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OF
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CONTENTS

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VOL. 35 APRIL 1913 NUMBER 4

The Society wishes to secure copies of the following issues of The Journal: January 1911, October 1911, November 1912. These will be purchased from members at 25 cents a copy, provided they are in good condition.

SPRING MEETING

There should be a large attendance at the Spring Meeting in Baltimore, which is to be held May 20-23, in view of the very complete arrangements which have been made by the Local Committee, Layton F. Smith, Chairman. The excursions will be of such a character that all will wish to participate in them, thus affording a splendid opportunity for the members to get together on each day of the convention. The engineering work which has recently been in progress at Baltimore in connection with the high-pressure fire system and the sewage system, will be of particular interest, and the trip to Annapolis should afford a day of rare enjoyment.

The headquarters of the Society, both for the professional sessions and for social events, will be the Hotel Belvedere. At this season of the year many visitors are in Baltimore, and members are strongly advised to secure reservations in advance by writing directly to the hotel. Besides the Belvedere there is the Hotel Stafford, three and one-half blocks away, and the Hotel Emerson, which is an eight minute ride on the trolley.

As usual the registration will begin on Tuesday, the 20th, and the meeting will open with an informal reception on the evening of that day. There will be professional sessions Wednesday and Thursday mornings only, unless it should be necessary to continue any of these into the afternoon.

The Local Committee have a carefully worked out program, comprising a series of excursions which are most attractive. The first of these will be on Wednesday afternoon, when there will be an excursion to the high-pressure pumping station, used for the new fire system of Baltimore, after which the guests are invited to witness an exhibition of the fire system. They will then be taken on a sail about the harbor to inspect the water front, shipping facilities and other things of interest.

On Thursday afternoon, there will be alternative excursions with an opportunity to inspect the new sewage pumping plant and the sewage disposal plant, both of which are among the most modern and complete in the country. On this afternoon, the ladies will be taken in automobiles for a tour about the city and to the country club, where tea will be served.

On Friday there will be an all-day excursion to Annapolis. In order to save time for a visit to the various buildings, the trip will be made by trolley. Upon arrival, the party will proceed to the State House, to be received by the Governor of Maryland. An address will then be given by Admiral H. I. Cone, engineer-in-chief of the Bureau of Steam Engineering, U. S. N., upon the United States Experimental Station at Annapolis. There will be luncheon at the Carvel House and the afternoon will be left free for the visit to the Naval Academy and to the experimental station. There is a possibility that there will be hydroaeroplane flights by officers and men of the aviation school, and evolutions of the submarine boats stationed at Annapolis.

The professional session on Wednesday morning will be opened with the usual business meeting and a presentation of several important and interesting reports of technical committees of the Society, followed by papers upon the miscellaneous subjects of Patents, the Performance of Automobile Trucks, and Mechanical Drawing. Simultaneously with this, there will be a session conducted by the Gas Power Section.

On Thursday, a session will be devoted to the topic of Fire Protection, in charge of the sub-committee upon this subject.

A lecture of a popular nature will be delivered on Wednesday evening, and the local committee have under consideration several topics of absorbing interest from which they will make a selection. Thursday evening will be the main reception and dance at the Belvedere.

This year the visiting members will be charged for luncheons and the car fare for excursions, thus relieving the local members of any burdensome expenditure in connection with the entertainment of their guests. It is believed that the visiting members will welcome the opportunity to contribute the small amount involved.

RAILROAD MEETING

The Society will hold a meeting under the direction of the sub-committee on Railroads on April 8, in the Engineering Societies Building, New York, on Steel Passenger Car Design and Equipment. The meeting is intended to bring before the membership the very latest developments of the art by specialists in each feature of steel passenger car design, and is the first meeting of the kind to be held by the Society.

The first session under the direction of this sub-committee took place at the Annual Meeting of the Society in December 1912, at which were considered the factors involved in the Selection of Locomotives and Train Lighting. Its success has led to the arrangements for the present meeting. The meeting will be open to all and representatives of various railroad organizations are expected to attend. An informal dinner at Keen's Chop House, 70 West 36th Street, will precede the meeting and all who wish to participate should meet in the rooms of the Society at 6.15 p.m.

The following is a list of those who will present papers and the phases of the subject which they will discuss:

Introduction to General Discussion of Steel Passenger Cars, H. H. Vaughan, assistant to vice-president, Canadian Pacific Railway.

The Problems of Steel Passenger Car Design, W. F. Kiesel, Jr., assistant mechanical engineer, Pennsylvania Railroad Company.

Underframes for Steel Passenger Cars, J. McE. Ames, American Car and Foundry Company.

Roof Structure for Steel Cars, C. A. Seley, mechanical engineer, Rock Island Lines.

Suspension of Steel Cars, E. W. Summers, president, Summers Steel Car Company.

Six-Wheel Trucks for Passenger Cars, J. A. Pilcher, mechanical engineer, Norfolk & Western Railway.

Steel Interior Finish for Steel Passenger Cars, FELIX KOCH, mechanical engineer, Pressed Steel Car Company.

Steel Interior Finish for Steel Passenger Cars, MARVIN SINGER, assistant mechanical engineer, Pullman Company.

Painting of Steel Passenger Cars, C. D. YOUNG, Engineer of Tests, Pennsylvania Railroad Company.

Provisions for Electric Lighting in Steel Passenger Cars, H. A. CURRIE, assistant electrical engineer, New York Central & Hudson River Railroad.

Provision for Electrical Equipment on Steel Motor Cars, F. W. BUTT, assistant engineer, New York Central & Hudson River Railroad.

Air Brakes for Heavy Steel Passenger Cars, A. L. HUMPHREY, vice-president and general manager, West Traction Brake Company.

Cast-Steel Double Body Bolster, Platforms and End Frames for Steel Cars, C. T. WESTLAKE, chief mechanical engineer, Commonwealth Steel Company.

Special Ends for Steel Passenger Cars, H. M. ESTABROOK, president, Barney & Smith Car Company.

Special Pressed Steel Shapes for Steel Cars, J. M. HANSEN, president, Standard Steel Car Company.

ORGANIZATION MEETING IN MINNEAPOLIS

A movement for organization of members of the Society in Minneapolis was set on foot at a large dinner at the Hotel Radisson on March 18, attended by over a hundred engineers from various parts of Minnesota. As a result of the meeting, it is proposed to establish a local headquarters for the members of the engineering profession in Minneapolis, with a free public reference library of engineering.

The meeting was presided over by Paul Doty of St. Paul, who introduced the Secretary of the Society, Calvin W. Rice, who had come on from New York especially to attend the dinner. Mr. Rice told of similar work being done in New York, Boston and St. Louis, and assured the members that its accomplishment in Minneapolis was only a question of time and would mean much benefit not only to the profession but to the community. He particularly emphasized the importance of all pulling together.

Mr. Rice was followed by Prof. J. J. Flather of the University of Minnesota, who spoke on the University in Relation to Mechanical Engineers, and by J. L. Record, president of the Minneapolis Steel and Machine Company, on the Industries and the Mechanical Engineer. Oliver Crosby, president of the American Hoist and Derrick Company, followed with some re-

marks upon the Mechanical Features of the Panama Canal, with which he is familiar, and C. L. Pillsbury of Minneapolis spoke of the Mechanical Engineer in Practice. The concluding remarks of the evening were made by Max Toltz of St. Paul, chairman of the committee in charge of the dinner, and the originator of the idea of coöperation among the engineers of Minnesota.

MEMORIAL TO ALEX. L. HOLLEY

The House Committee has on exhibition in the Council Room a bronze bust of Alexander L. Holley, our honorary member in perpetuity. This study is by William Ordway Partridge of New York, and is offered for criticism in the hope that a perfect portrait in bronze may be the result, as a permanent reminder of this great engineer. It is requested that all of the members of the Society who were personally acquainted with Mr. Holley inspect this bust and send their criticisms to the Chairman of the House Committee, Edward Van Winkle, 90 West Street, New York City. It is the desire to incorporate these suggestions of the members who were intimate with Holley in a report to the sculptor so that he may be aided in the production of a perfect likeness.

We are particularly fortunate in obtaining the services of Mr. Partridge, who has executed many works for the city, state and federal governments, among them the equestrian statue of General Grant in Brooklyn, Alexander Hamilton at Columbia University, and the Hamilton and Jeffersonian statues in Washington.

MEETING IN GERMANY, 1913

The itinerary of the visit of the Society to Germany by invitation of the Verein deutscher Ingenieure and in connection with its annual meeting will be as follows:

TENTATIVE PROGRAM

NEW YORK

Tuesday, June 10

10.00 a. m. The party sails on the Hamburg-American S. S. Victoria Luise (remodeled "Deutschland") from Hoboken. It will be advisable for members of the party to reach New York not later than June 9.

Representatives of the Verein deutscher Ingenieure will come on board at Cherbourg to receive the visitors.

HAMBURG

Thursday, June 19

Arrival in Hamburg.

Friday, June 20

11.00 a. m. Address: The Hamburg Harbor
11.00 a. m. to 1.00 p. m. Trip around the harbor
5.30 p. m. Reception in the Municipal Hall by the Senate of the city and by the Hamburg Section of the Verein deutscher Ingenieure

Saturday, June 21

10.00 a. m. Excursions
Group 1: Inspection of the Elbe tunnel and visit to the shipyards of Blohm and Voss
Group 2: Visit to the Vulcan yards and inspection of the Elbe tunnel

Sunday, June 22

10.00 a. m. Departure for Leipzig

LEIPZIG

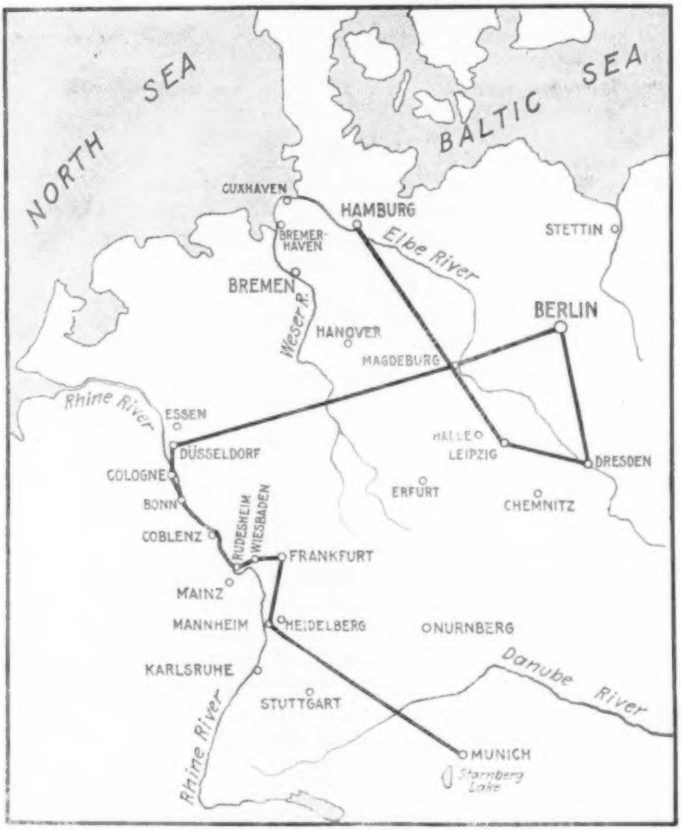
Sunday, June 2

4.30 p. m. Arrival in Leipzig
8.00 p. m. Reception in the Crystal Palace

LEIPZIG

Monday, June 23

10.00 a. m. Formal meeting in the Municipal Hall
5.00 p. m. Concert under the direction of Mr. Arthur Nikisch in the Gewandhaus
7.30 p. m. Formal dinner in Central Theater



ITINERARY OF OFFICIAL TOUR IN GERMANY

Tuesday, June 24

9.30 a. m. Scientific Lectures in the lecture room of the Architectural Exhibition
4.30 p. m. Inspection of the Monument of the Battle of Nations in commemoration of 100th anniversary of the battle of Leipzig, 1813
8.00 p. m. Festival in the Palm Garden

LEIPZIG

Wednesday, June 25

9.10 a. m. Departure for Dresden

DRESDEN

Wednesday, June 25

11.00 a. m. Arrival in Dresden
2.00 p. m. Gather at the Belvedere; automobile trip to the Saxon Switzerland (Bastei), walk to Rathen, by steamer to Pirna, by automobile to Dresden.
8.30 p. m. Reception in the Municipal Building, tendered by the city of Dresden.

Thursday, June 26

9.30 a. m. Excursion through Dresden
- Group 3: Machine Laboratory of the Technical High School
- Group 4: Seidel & Naumann Sewing Machine and Bicycle Factory
- Group 5: Picture Gallery

12.30 p. m. Lunch in the Neustadt railway terminal
2.00 p. m. Departure for Berlin

BERLIN

Thursday, June 26

5.00 p. m. Arrival in Berlin
8.00 p. m. Reception in the Reichstag Building

Friday, June 27

9.30 a. m. Excursions
- Group 6: Allgemeine-Elektricitäts Gesellschaft
- Group 7: Siemens-Schuckert Works
- Group 8: Bergmann Electrical Company
- Group 9: Ludwig Loewe Company, Machine Tool Factory
- Group 10: A. Borsig Locomotive Works in Berlin-Tegel
- Group 11: Ladies' excursion and lunch

8.00 p. m. Formal dinner in the Zoological Garden

Saturday, June 28

2.30 p. m. Automobile trip to Potsdam and steamer trip on the Havel
7.00 p. m. Entertainment by the Berlin Local Section in Wannsee

Sunday, June 29

8.00 a. m. Departure for Düsseldorf, Rhine-Westphalia

DÜSSELDORF

Sunday, June 29

6.00 p. m. Arrival in Düsseldorf
8.00 p. m. Reception in the City Hall tendered by the city of Düsseldorf

DÜSSELDORF

Monday, June 30

9.00 a. m. Excursions

Group 12: Duisburg works of the German Machine Works Company (50 participants)

Group 13: Friedrich-Alfred steel plant of the Friedr. Krupp Co. in Rheinhausen (75 participants)

Group 14: Machine Works of Thyssen & Co. in Muhlheim (Ruhr) (20 participants)

Group 15: Gutehoffnung Steel Plant, Oberhausen Rheinland (40 participants)

Group 16: Rhein Steel Works, Duisburg-Meiderich (50 participants)

Group 17: In the morning the ladies inspect the city of Düsseldorf, and in the evening the welfare activities of Friedr. Krupp Co. in Essen

Group 18: Afternoon inspection of the Duisburg-Ruhrort harbor by the members of groups 12 to 16, as well as others who apply for it

The other visitors will be afforded an opportunity to see the city of Düsseldorf

8.00 p. m. Banquet in the city concert hall of Düsseldorf tendered by the Rhine-Westphalian Section of the Verein deutscher Ingenieure

Tuesday, July 1

9.00 a. m. Excursions

Group 19: Haniel & Lueg, Düsseldorf-Grafenberg (50 participants)

Group 20: Ernst Schiess Company, Düsseldorf (50 participants)

Group 21: German Machine Works Company, Benrath plant, Benrath (50 participants)

Group 22: Steel Works of Becker Company, Willich b./Krefeld (75 participants)

Group 23: Trip into the mountains; inspection of the Elberfeld Lift railway, Barmer mountain railway, steel plant of Rich. Lindeberg Company, Remscheid-Hasten and the Mungsten Bridge

Group 24: The ladies will inspect some installations in the city of Düsseldorf

4.30 p. m. Departure for Cologne. Members of Group 23 go from Remscheid direct to Cologne

COLOGNE

Tuesday, July 1

5.30 p. m. Arrival in Cologne

8.00 p. m. Informal gathering in the Zoological Garden of Cologne tendered by the Rhine-Westfalen Board. Trip on the Rhine with illumination of the city and cathedral

COLOGNE

Wednesday, July 2

9.00 a. m.	Excursions
	Group 25: Dye Works, formerly Friedr. Bayer & Co. Leverkusen (up to 100 participants)
	Group 26: Gas Engine Works, Deutz, Cologne-Deutz (up to 100 participants)
	Group 27: Machine Works Humboldt, Cologne-Kalk (up to 100 participants)
	Group 28: The ladies inspect the cathedral and city
8.00 p. m.	Reception in Gurzenich tendered by the city of Cologne

Thursday, July 3

8.00 a. m.	Departure by rail for Coblenz; thence on the Rhine by steamer to Rüdesheim, where there will be a festival on the banks, and thence by rail to Frankfort-on-Main

FRANKFORT-ON-MAIN

Thursday, July 3

6.00 p. m.	Arrival in Frankfort-on-Main
8.00 p. m.	Reception in the Palm Garden by the Frankfort Section of the Verein deutscher Ingenieure

Friday, July 4

11.30 a. m.	Welcome by the city in Roemer. Luncheon
2.30 p. m.	Excursions
	Group 29: Eastern port and gas works
	Group 30: Stockyards and gasholders
	Group 31: Refuse destroyer plant and filters
	Group 32: Inspection of the old city, Goethe house, Historical Museum
	Group 33: Visit to Saalburg
7.30 p. m.	Independence Day celebration with the American colony

Saturday, July 5

10.30 a. m.	Departure for Mannheim

MANNHEIM

Saturday, July 5

12.00 m.	Arrival; lunch in the Friedrichspark
	Excursions
	Group 34: Machine Works, Heinrich Lanz
	Group 35: Machine Works, Sulzer Bros. in Ludwigshafen
	Group 36: Brown-Boveri & Co., electric machinery
	Group 37: Cement Works in Leinen and their welfare activities

Group 38: Benz & Co. Rhine Automobile and Motor Works Company
Group 39: Inspection of the port (steam flour mills in Ludwigshafen)

8.00 p. m. Reception of welcome

Sunday, July 6

11.00 a. m. Departure for Heidelberg

HEIDELBERG

Sunday, July 6

12.00 m. Arrival; lunch in the Stadtgarten, inspection of the Castle, concert in the Castle Restaurant
6.00 p. m. Dinner on the Molkenkur tendered by the Board of Reception
10.00 p. m. Trip to the Castle, illuminated by fireworks, given by the City of Heidelberg
11.00 p. m. Return to Mannheim

MANNHEIM

Monday, July 7

10.00 a. m. Departure for Munich

MUNICH

Monday, July 7

5.00 p. m. Arrival in Munich
8.00 p. m. Reception of welcome in the Hofbrauhaus

Tuesday, July 8

9.30 a. m. Inspection of the German Museum and its new building
3.00 p. m. Trip to the Sternberger See
8.00 p. m. Concluding exercises in the Rathhaus

So large a proportion of the membership and their friends have expressed a desire to participate in this trip, that reservations are now practically closed, and a waiting list of ladies has already become necessary. Any vacancies which may occur in the party will be filled by subsequent requests, in the order of their receipt.

Circulars containing complete information as to the details of the trip have been issued to those who will participate, and any further data may be secured from the headquarters of the Society. The Verein deutscher Ingenieure is preparing for the use of all participants a detailed guide-book for the trip, containing a general description of the cities to be visited and of all the industrial establishments included in the tour.

DEATH OF SIR WILLIAM ARROL

Two factors will always be found in any engineering structure of magnitude. The first is the scientific or design factor supplied by knowledge of physical law. The second is the craftsmanship, or the experience and skill evidenced in embodying the design in material form. The first requirement is for technical knowledge and experience. The second calls for knowledge of men, experience, credit and administrative capacity. In the United States the economic trend has been in the direction of meeting the need of the hour by means of standard constructions. The design and the engineering skill are both supplied by the constructor from within his organization and the constructor as contractor supplies the finished work to the user. This makes for economy in many directions. The British system has been to have the design and the engineering skill and responsibility furnished by one party who will usually be called a consulting engineer, and the craftsmanship and execution of the work confided to some one entirely different. The consulting engineer sees only that his design is properly carried out. The skill and economies of the process of construction and erection are confided to the contractor. The latter makes the money if there is any profit to be made.

Sir William Arrol and the Dalmarnock Works near Glasgow, Scotland, furnish a noteworthy example of the best application of the British principle. Sir William owed his advancement to his splendid ability and courage in the attack of big problems, and his success financially to his attacking these problems in a large way, and applying machinery on a large scale to effecting economies in construction. His engineering office was not engaged on problems of outside design. It was directed to the making of the details which were required to produce economically and effectively the material and the erection of the designs of others.

He was born in 1839. His father was a Scotch cotton spinner

and rose to become manager of the great Coats Thread Works of Paisley. William entered the works under his father's management as a boy in the woodworking shop, but at the age of fourteen he evidenced his preference for metal working and he entered the blacksmith shop of Mr. Thomas Reid. An apprenticeship lasted four years in those days and during a period of six years thereafter he traveled as journeyman in various parts of Scotland and England. At twenty-four he became foreman of the bridge and boiler departments of the works of Laidlaw & Sons, remaining with them for five years. In 1868, or when he was twenty-nine years of age, he invested his savings of 85 pounds sterling in a little plant in the outskirts of Glasgow for machinery repairing, boilermaking and general blacksmithing. More than one-half his capital went into the engine and boiler alone. Business must have come to the young energy and enthusiasm of the little shop, for extensions became necessary and it was in 1871 that the Dalmarnock Works were begun with about thirty men. The ability and capacity which have come with opportunity developed that modest beginning into the plant of today, covering some twenty acres and employing when in full operation about 5000 men.

The foundation of his fame as a bridge builder and constructor was early laid by a long multiple-span bridge for the Caledonian Railway across the Clyde. He introduced in these bridges what was at that time the entirely novel method of erection on the ground, constructing the span without false work and rolling each girder out over the piers until it could be dropped into position. This method attracted the attention of all the engineers and work immediately began to flow in. The viaduct over the Clyde at Glasgow gave opportunity for his design and application of multiple drilling in the field and the hydraulic riveter. This was in 1875.

It will be recalled that in 1879 England experienced one of its great engineering disasters in the wreckage of the bridge over the Tay. The bridge had to be re-erected and Mr. W. H. Barlow was entrusted with the work and made Mr. Arrol his contractor. The rebuilding of the bridge took five years and was completed in 1887 with 74 spans and a total length of 10,700 feet. It has withstood all attacks from the tempestuous gales from the North Sea to which it is exposed. The success of this undertaking led Sir John Fowler and Mr. Benjamin Baker in

coöperation with Mr. Arrol to undertake the great cantilever to cross the Firth of Forth. Tunnels and suspension designs were carefully investigated, but while a cantilever principle was decided upon as the most feasible, the dimensions were far in excess of anything that had been attempted before. The two main spans are 1710 feet long with a headway below the center span of 150 feet above the water. The towers are a little above 360 feet high. The scale of the work to be done called again for special plant and the value of the investment on the ground has been estimated at over a million dollars. It was at this time that Mr. Arrol produced an oil fired furnace for heating rivets and greatly improved the hydraulic riveting machines. It was at the Forth Bridge that Mr. Arrol invented what has been called the hydraulic spade to work in the resistant boulder clay into which the caissons had to be forced. Queen Victoria conferred the honor of knighthood on the successful contractor on the opening of the bridge in 1890 and in that same year he received the honorary degree of LL.D. from the University of Glasgow. The Forth Bridge was still building when the contract came for the steel work of the Tower Bridge of London with its 200 feet clear opening and its lifting bascules of 1200 tons each. In addition Sir William's firm did a great deal of viaduct and swing bridge work for the Manchester Ship Canal, for bridges over the Nile at Cairo, for a bridge with the widest span in England over the Wear at Sunderland, and elsewhere both in England and in the colonies. The organization of the Dalmarnock Works was made into a limited liability company in 1895 and the building of steel factory and railway structures was made a part of the business. Sir William was a great believer in abundance of light as a factor in successive and rapid production, and favored the modern steel glass roof construction.

Fame came to him in other directions and he sat in Parliament from 1895-1906. He was not a talker but was much relied upon by his colleagues for his sound advice in industrial legislation in committees. He was a Fellow of the Royal Society of Edinburgh and other scientific and philanthropical organizations. The Institution of Engineers and Shipbuilders in Scotland honored him with its Presidency in 1895 and in that same year The American Society of Mechanical Engineers elected him an Honorary Member. The letter which started that movement

in the Society was signed by Mr. Andrew Carnegie, who had long admired the man and his methods.

His personal character was one of rare charm, sympathetic, tactful, warm-hearted and generous. His capacity for attention to detail was renowned and his energy phenomenal. He died after several weeks' illness from an attack of influenza on February 20, 1913.

DISCUSSION ON REPORT OF THE COMMITTEE ON STANDARD CROSS-SECTIONS AND SYMBOLS

A. A. Adler said that he felt there was no demand for standard cross-sections and saw no advantage in them. To show how cumbersome the system is it will be observed that nickel, chrome and vanadium steels are marked in addition to their characteristic cross-sectioning. This is due to the limited number of combinations that may be formed by the variety of lines used.

A much more serious objection is found in the burden that such a set of standards would impose upon the memory. In order to insure that the workman would use the intended materials, a legend would have to be employed to describe the meaning of the standards. This appears contrary to logical procedure. The present method of specifying the material in a "material list" is by far the most convenient method, as it also includes heat treatment and such other data as are necessary for accurate description.

There is, however, one possible use for such standard cross-sections as, for instance, where a change of section indicates a change of material. But in this case no standards of any kind seem necessary.

J. H. Norris said that in his practise he had used about 12 different compositions of what is listed in the report (Fig. 1) as "copper, brass or composition." He had for years sectionalized simply with a plain line, and then marking the materials, although this latter was not usually done, but was indicated on the material list accompanying the drawings. Then if the material is changed, the drawing does not have to be corrected but simply the list. The list of standards proposed seemed to him to be unnecessary.

Presented at the Annual Meeting 1912, of The American Society of Mechanical Engineers. This report appears in The Journal for December 1912.

A. E. Norton thought that Professor Adler had misinterpreted Fig. 2 in respect to the use of printed labels to indicate chrome steel, nickel steel and other variations of chemical composition.

Such labeling is entirely optional, the hatching lines being used only to indicate the process of manufacture, that is, whether the steel is a casting or a forging.

F. De R. Furman, speaking as a member of the committee, said that the putting out of these specifications for the representation of different materials had been induced by the fact that a number of different standards are in use in different drafting rooms. It seemed a desirable thing to secure coöperation between the drafting rooms, which already used a special kind of cross-section line, and have them adopt a uniform standard, to avoid confusion.

Spencer Miller regarded the plan as valuable since it allows of the adoption of as many or as few of these standards as may be desired in any drawing room. If any plan is to be adopted at all by a drafting room, it would seem better to adopt one which others have agreed to.

L. P. Alford and Arthur L. Ormay.[1] The authors of this discussion are firm believers in the principle of engineering standardization and its application to engineering work. Thus when the report of the Committee on Standard Cross-sections and Symbols was published, they at once turned to it with the purpose of adopting the standards there recommended in their own work. Careful study, however, led to the conclusion that it was impractical to make use of the material thus presented, for a number of reasons, and further consideration led to the preparation of this discussion.

The most serious objection is incompleteness. There are no symbols for a large number of the materials frequently used in mechanical engineering and represented on drawings of members of this Society. Other objections are, a failure to use lines of uniform direction, the sacrifice of individuality in the sym-

[1] Chief draftsman, Hill Publishing Co., New York.

bols to a uniform weight of line, and finally an apparent failure to consider the practise and standardization work of others. Further, the general scheme of classification is open to a difference of opinion, for another viewpoint has been taken in the cross-sections and symbols accompanying this discussion.

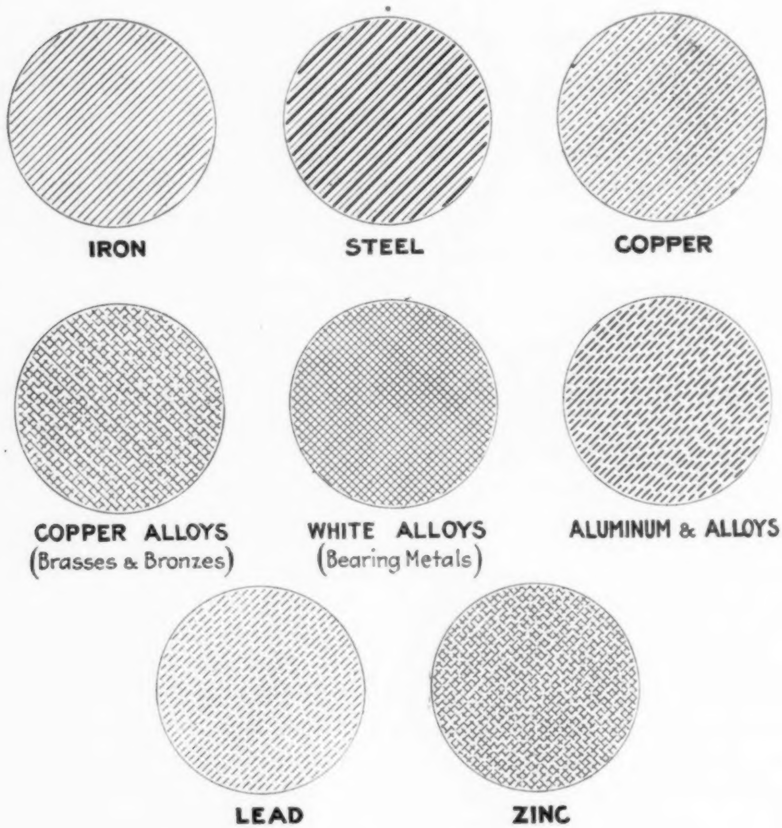


Fig. 3 Cross-Sections for Metals

The Symbols Suggested. The meaning of these objections can best be seen by turning to the symbols shown in Figs. 3-6, which are offered by way of suggestion. There are four groups: cross-sections for metals (Fig. 3), symbols for building materials (Fig. 4), symbols for geologic formations (Fig. 5), and symbols for miscellaneous materials (Fig. 6).

In all of these cross-sections and symbols having ruled lines, the direction of the lines is standardized to two, horizontal and inclined at an angle of 45 deg. with the horizontal. In addition to these the committee's report includes inclined lines, at an angle

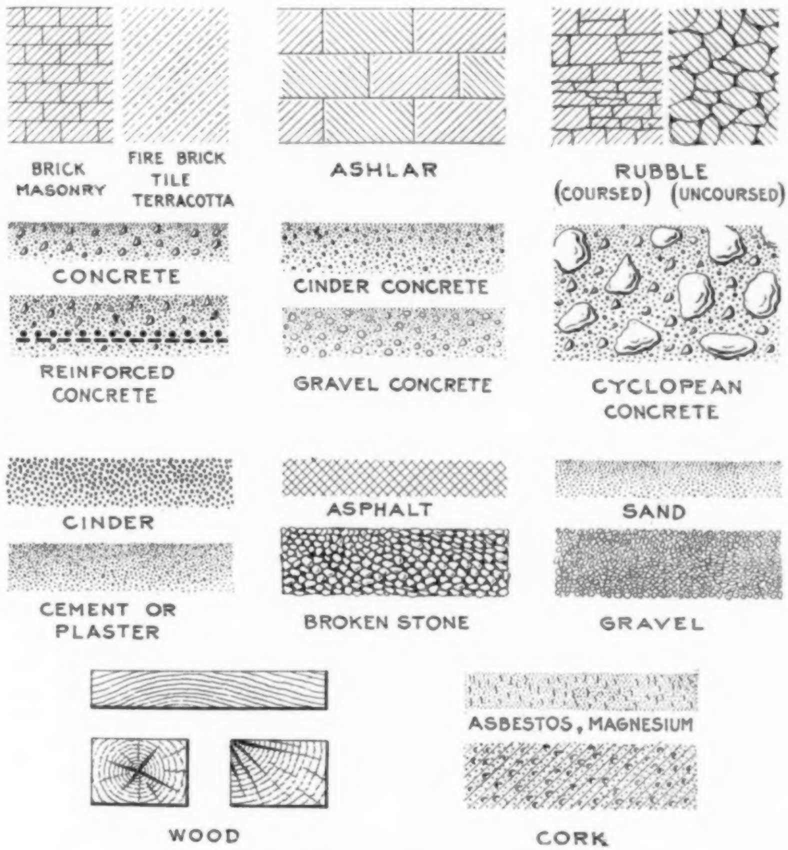


Fig. 4 Symbols for Building Materials

of 30 deg. with the horizontal, as seen in the symbol for babbitt or white metal.

Four weights of line are used. The committee's report standardized this feature to a single one. This is a simplification of practise at the expense of result. To the authors' minds such a course is unjustifiable. The quality of the results can be judged by referring to the cross-sections for wrought iron, cast steel

and wrought steel in the committee's report. From the casual glance of a person familiar with reading drawings, there is but little difference between these cross-sections, not enough to individualize any one of them. In fact, these are so similar that it is doubtful if draftsmen would readily remember them and their differences.

As a detail in the method of presenting these suggested cross-

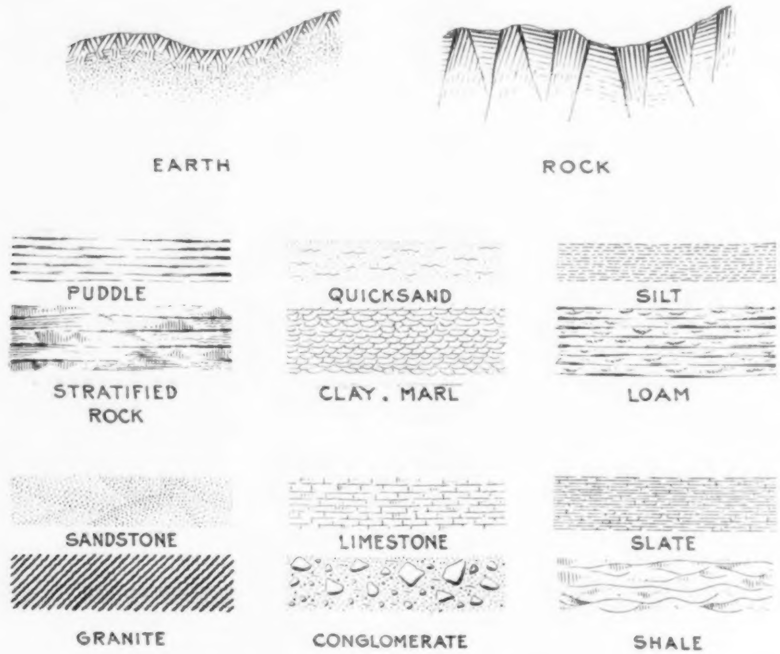


FIG. 5 SYMBOLS FOR GEOLOGIC FORMATIONS

sections and symbols, a difference in form has been made for different materials. This is intended to have some reference to the shape in which the material is met with or used in engineering work. That is, the metal cross-sections are presented by a circular cross-hatched area which might represent the end of a bar, or rod. Earth and rock are shown by an irregular outline that might be part of a section of a bank or ledge. This same idea has been carried out in connection with some of the others.

The general scheme followed in developing this series has been to distinguish between families of materials by cross-sections

and symbols easily remembered, and then make use of abbreviations or names to distinguish subdivisions of these groups. This group system is best illustrated by the cross-sections for metals and the symbols for concrete.

Cross-Sections for Metals. The metals group has eight cross-

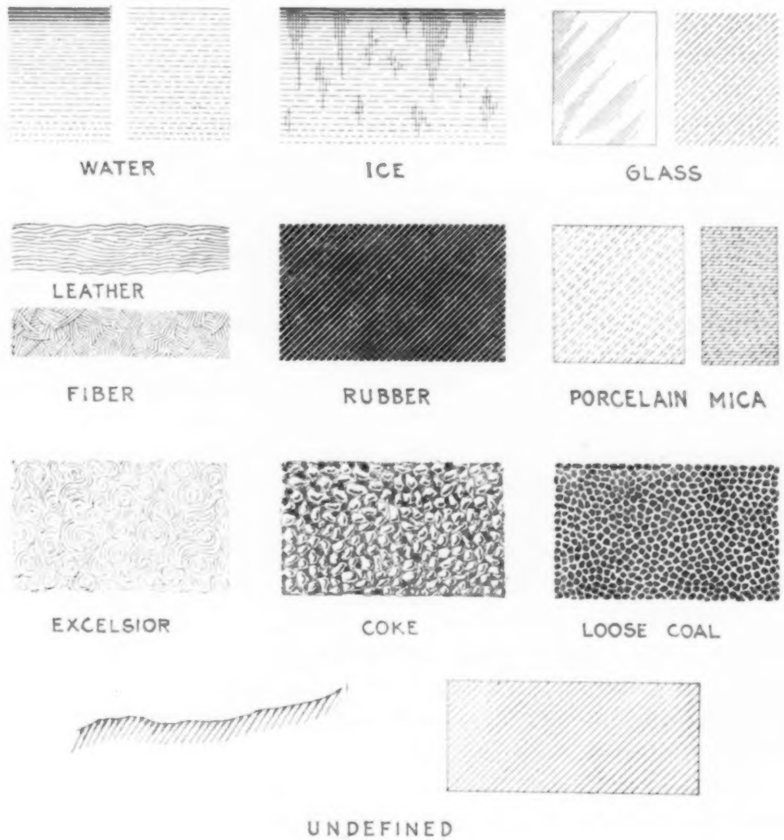


FIG. 6 SYMBOLS FOR MISCELLANEOUS MATERIALS

sections (Fig. 3); of these, five are family groups. The iron group includes cast iron, malleable iron, wrought iron, ingot iron and perhaps others. The steel group includes tool and cast steel, high-speed steel, crucible and high-carbon steel, alloy steels, as nickel, manganese, chrome nickel, vanadium, and the ordinary steels of machinery construction, such as bessemer, cold rolled, open hearth, machinery, cold drawn and low carbon. The copper

alloys include brasses and bronzes in all their variety; white alloys include babbitt and all kinds of white metals; and the aluminum group aluminum and its alloys. The other three symbols are for copper, lead and zinc, respectively. It should be noted that the copper alloy cross-section is a combination of the copper and lead rulings.

It is believed that these cross-sections cover all of the important families and ordinary engineering metals that are used unalloyed. In practise, the symbol for iron would ordinarily be applied to cast iron, and if any of the other kinds were to be specified its abbreviation or name would be printed across the section. Similarly the steel cross-section would be taken to mean a low-carbon machinery steel and the other grades indicated by abbreviations or names. This same method could be applied to the copper alloys.

Symbols for Building Materials. But little comment need be given to the 19 symbols for building materials (Fig. 4), except that those presented are believed to cover the ordinary materials met with in the work of members of this Society. Attention is called to the symbol for ashlar, which is believed to represent this important material better than the one shown in the committee's report.

Symbols for Geologic Formation. Here are 14 symbols (Fig. 5), which are believed to cover the formations ordinarily met by members of this Society in connection with foundations for buildings, dams, and other engineering structures. In general, they follow the symbols prepared and published by the United States Geological Survey, and thus have the advantage of being already in use.

Symbols for Miscellaneous Materials. The symbols for miscellaneous materials (Fig. 6) are 11 in number. Some of these may seem new, but all have found use in the work of the authors. The reason for most of them is apparent. By way of explanation, excelsior, coke and coal are represented on power plant drawings, in cross-sections of boilers, coal pockets, gas producers and gas scrubbers, as the case may be.

The final symbol on this chart is for undefined or unclassified material, and follows the suggestion contained in the committee's report.

In conclusion, the authors have written this discussion with a

single motive, that of aiding in the constructive work of preparing a series of cross-sections and symbols adequate to the entire field of the work of the mechanical engineer and arranged in a form to be adopted and used. It is hoped that the report which has been discussed will be considered merely as preliminary and that further consideration will be given to this important subject.

In connection with further work, two suggestions are in order. The first is the preparation of a series of abbreviations of the names of the materials forming the subdivisions of the general groups. The second is much broader and is to make a complete study of drawing-room conventions. The modern conception of mechanical drawing is that it is an engineering language. Though this characterization is true, it is a language without uniformity, without grammar, and filled with dialect and peculiarities of expression. A careful investigation of mechanical drawing conventions, with a report putting them in comprehensive form, would be of great value to the members of this Society and to our engineering colleges.

O. K. Harlan wrote that for the cross-sectioning for wrought iron he would prefer a light and heavy line in pairs, similar to that for cast steel but having one of the two light lines made heavier. This has been used for many years and he believed to be now in quite general use. It gives a clearer distinction between wrought iron and steel than the sections shown in the report, and can be made with the same number of strokes of the pen by retracing one of the two light lines and making it twice as heavy. The sections shown in the report require a second glance to tell which is which, wrought iron or steel, since they are so nearly alike.

The sectioning for rubber did not seem to him to be the best obtainable. Insulation as used in electrical work often involves small pieces, and to use the sectioning shown would admit of confusion between the section lines and the actual lines of the mechanism. In some cases he had used solid black, as rivet holes are sometimes shown in structural steel work, and he had also used soft black pencil on the tracing, which gives an effect on the print which is easily distinguishable. By lettering hard rubber, fiber, vulcanite, etc., in ink on the tracing, it shows clearly on the print and seems to cause less confusion than the light hori-

zontal lines recommended by the committee. He was not disposed, however, to urge the use as standard of either the black pencil or solid black ink.

The Authors. Referring to the suggestion of using lines of more than one thickness, the committee have reached the conclusion, after careful consideration, that lines of uniform thickness will not only facilitate the drawing of cross-sections, but will save much time in waiting for heavy ink lines to dry. If draftsmen had always been in the habit of using lines of uniform thickness in cross-section work, the committee doubt very much if they would now adopt sections made of lines having variable weights.

The underlying principle of the standard sections recommended is the use of single lines for cast iron, then the wrought and forged irons are indicated by making every alternate line double. In a similar way cast steel is shown by double lines in pairs and all the wrought and forged steels by adding an additional line to each alternate pair.

The committee have avoided the use of dotted lines in all cross-section work, except when such lines are used in combination with solid lines, thus preventing confusion with dotted lines which represent objects behind the plane of section.

It is true that frequently rubber and insulation materials are shown in solid black. When these sections are narrow there is no objection to this practise, but when the sections are wide, heavy patches of ink tend to crumple the tracing cloth or paper, and in such cases the section recommended by the committee would be clearer and not liable to confusion.

In cross-sections showing babbitt or white metal, which usually occur in narrow widths, the committee recommend the use of a 30-60 deg. line because it facilitates the act of drawing by requiring a fewer number of lines.

The committee believe it would not be wise to attempt to formulate a standard for every material.

Symbols for various building materials; symbols for geologic formations and symbols for miscellaneous materials, the committee believe, are best worked out by subdividing one of the standard cross-sections as recommended, according to the scheme reported on by the committee under typical subdivisions. Such subdivisions are chiefly used by specific trades or by those work-

ing along particular lines. The committee see no objection to the use of many of the symbols submitted by Mr. L. P. Alford and Mr. Arthur L. Ormay, but believe that they should be classified under typical subdivisions, rather than included as standard cross-sections or symbols.

THE PROTECTION OF MAIN BELT DRIVES WITH FIRE RETARDANT PARTITIONS

WITH OBSERVATIONS ON THE SAFEGUARDING OF VERTICAL OPENINGS THROUGH FLOORS AND THE RELATION OF SUCH PROTECTION TO THE SAFETY OF OPERATIVES EMPLOYED IN MANUFACTURING ESTABLISHMENTS

By C. H. Smith

ABSTRACT OF PAPER

In manufacturing establishments approved forms of construction and complete fire protection have proved their value not only in reducing property losses by fire, but in promoting the safety of the operatives employed as well. The importance of safeguarding the vertical openings through floors at stairs and elevators by placing them in towers well cut off from the remainder of the building has long been recognized.

The need of adopting similar safeguards at belt or rope drives was less fully appreciated, and the introduction of such protection was handicapped by the lack of a construction suitable for use in mill buildings where the belt or rope towers were not provided for in the original design. Partitions of expanded metal and cement construction 2 in. or more in thickness have been found well adapted for the enclosure of such main drives in existing buildings. Such fire retardant partitions are also adaptable for the enclosure of stairways and elevators where the hazards are not too great and where walls of brick or of concrete cannot well be employed. Also for the segregation of special hazards, the construction of bins for inflammable stock, the separation of lacquer rooms, and the like. These cement partitions can be installed at a cost not greatly in excess of the combustible forms of construction usually employed.

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By C. H. Smith,[1] Boston, Mass.

Non-Member

The importance of safeguarding stairways by placing them in towers well cut off from the remainder of the building and of protecting the openings made by elevators through the floors has long been recognized. Today more than formerly, these features are taken care of in the design of manufacturing buildings, including also well arranged towers for the main belts or ropes where this method of driving is employed. Fig. 1 shows how these features may be taken care of in a textile mill.

2 The following remarks apply more particularly to the older manufacturing buildings and to those of more recent construction where the best principles of design of stair and elevator towers and belt and ropeways have not been followed. Neglect to safeguard vertical openings through floors has resulted in serious loss of life among occupants of the building, who found themselves cut off from their accustomed exits by the rapid spread of fire up through such unprotected openings.

3 In mills insured with the Mutual companies stairs and elevators have generally been well arranged, and the fire protective devices such as automatic sprinkler systems, etc., have shown their value not only in reducing the loss of property by fire to a minimum, but also it has been demonstrated that approved construction, high standards of general order and neatness and efficient fire protection works as well to safeguard the lives of operatives employed.

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The American Society of Mechanical Engineers, 29 West 39th Street, New York. All papers are subject to revision.

4 At the present time there are approximately 1,500,000 people employed in the 2800 industrial works insured with the Mutual companies, located in 29 states of the Union and Canada. Since the inception of the system in 1835, there have been but 32 deaths caused directly by fires in these properties and 21 were in a fire in an unsprinklered mill in 1876 before sprinklers were in general use. This would indicate that under present condi-

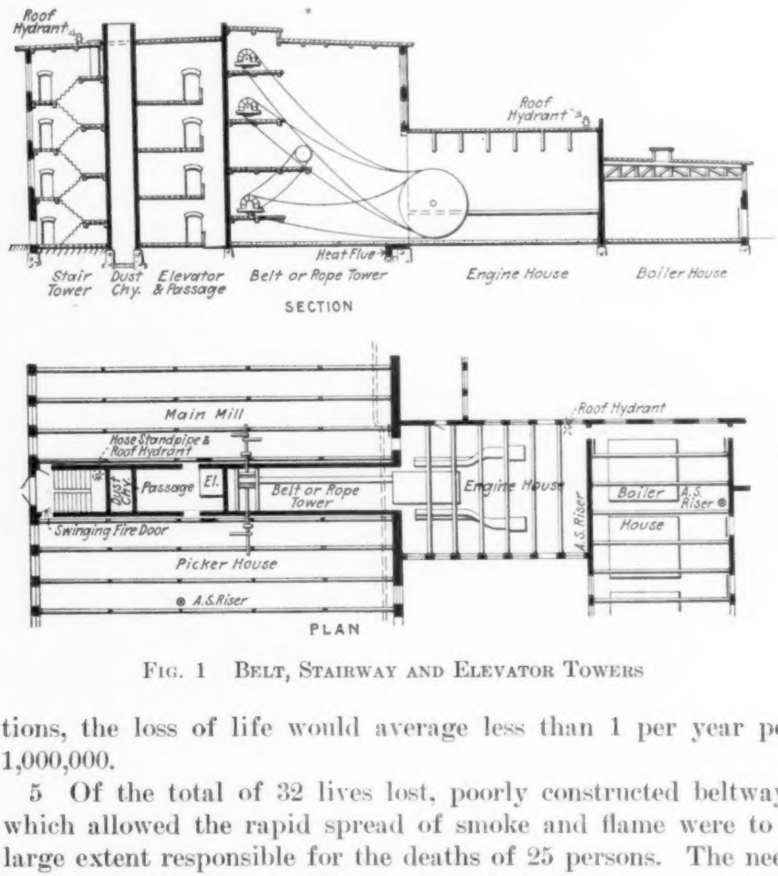

Fig. 1 Belt, Stairway and Elevator Towers

tions, the loss of life would average less than 1 per year per 1,000,000.

5 Of the total of 32 lives lost, poorly constructed beltways which allowed the rapid spread of smoke and flame were to a large extent responsible for the deaths of 25 persons. The need of safeguarding the vertical openings through floors around the main driving belts had been less fully appreciated. Conditions at these drives were aggravated moreover, because it was the general custom to enclose the belts with boxes of wood, which in some cases were about head high and in others extended to the ceiling. The boxes tended to become oil soaked and to ac-

cumulate lint. A fire once starting at or near them would rapidly make headway, being carried by the natural draft up through the mill. Such a fire would also be more or less sheltered from the action of the sprinklers in the room.

6 The recurrence of several large property losses from this source led to consideration of this matter and measures were taken which have to a great extent eliminated the open beltway hazard from Mutual risks. In the experience of these companies there have been about 20 fires occurring in the vicinity of main

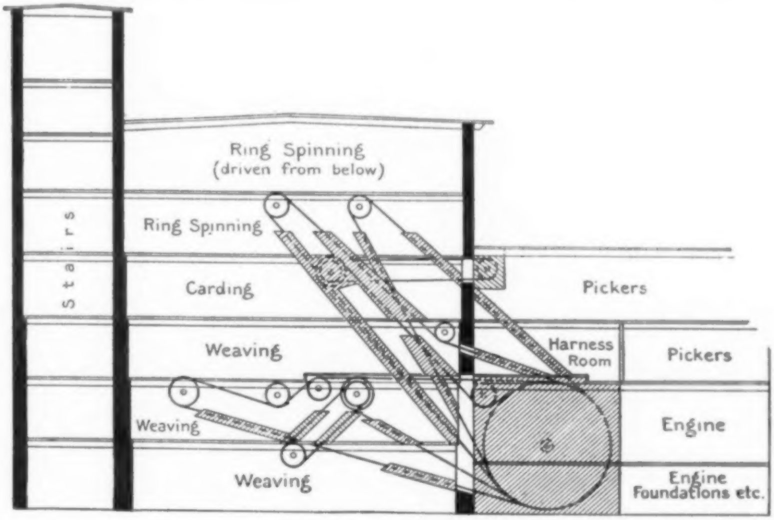

FIG. 2 SECTION SHOWING BELTS AND WOODEN BOXING BEFORE FIRE OF SEPTEMBER 15, 1907

drives in which the open beltway was an important factor in the spread of the fire. These 20 fires resulted in a total loss of $2,721,635, an average of $136,082 per fire. Some of the larger of these losses occurred in the days before sprinkler protection was as complete as now, but the statistics showed that even with complete protection the open beltway was a serious hazard.

7 The last bad fire from this source occurred September 15, 1907, at a cotton manufacturing establishment in Fall River. This is a stone mill, 339 ft. long, 74 ft. wide and five stories and basement in height with a 4-story wing, 94 ft. long and 65 ft. wide, projecting from the rear at the center of the mill. The engine room was located in the first story of this wing. The

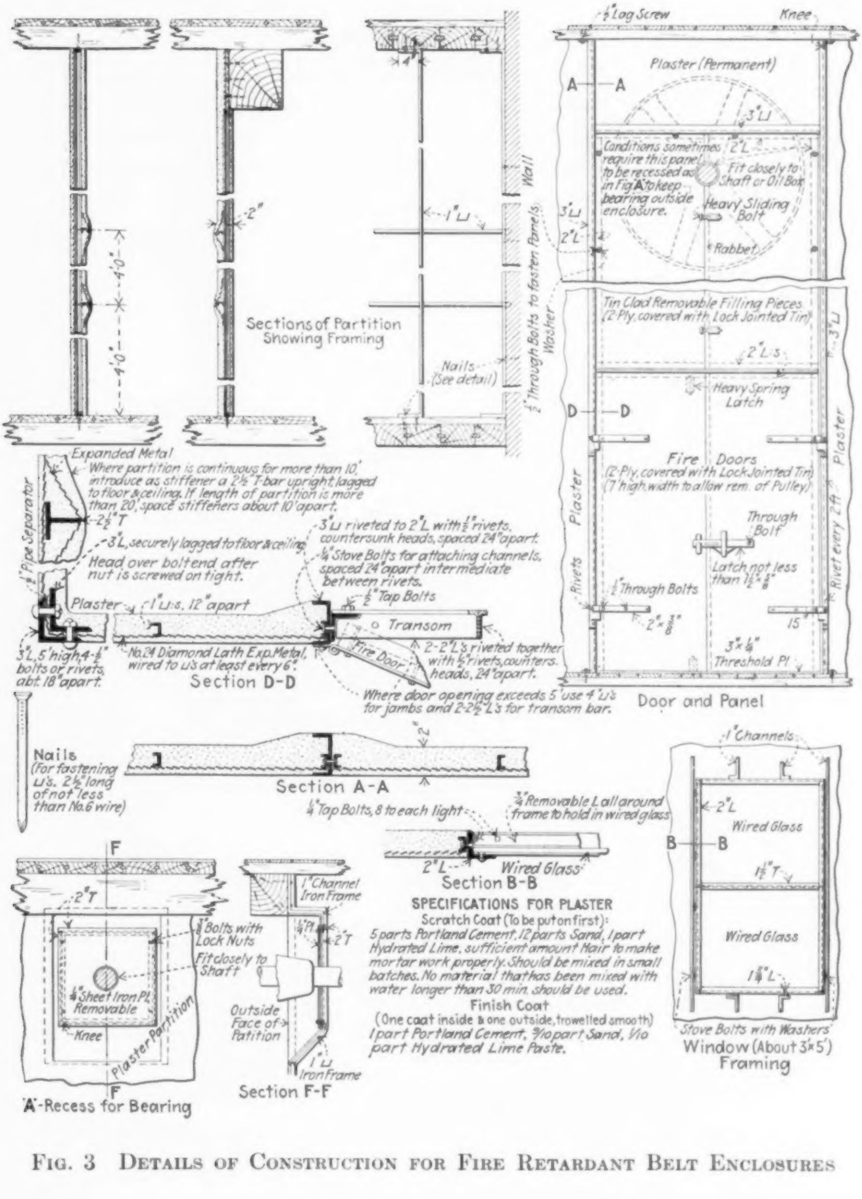

FIG. 3 DETAILS OF CONSTRUCTION FOR FIRE RETARDANT BELT ENCLOSURES

belts were boxed with wood and most of these were cut off head high in the several stories. Fig. 2 shows the general arrangement of the drive.

8 Sunday forenoon a bearing in the beltway just above the flywheel was being repaired. While the man doing the work stated that he had no knowledge of anything that could cause the fire, it is probable that its origin was connected with his work. After completing the job he left the locality. On returning 10 minutes later, he saw fire just below where he had been at work, and gave the alarm.

9 The fire passed up through the wooden belt boxing into all stories as far as the fourth floor where the drive terminated. The mill filled with heat and smoke so rapidly that in 5 minutes no one could enter the rooms. This was in spite of 650 sprinklers which opened, but in justice to the sprinkler equipment, it should be stated that the water pressure at this mill was weak. A section about 50 ft. wide was badly burned on each side of the main drive up through the mill.

10 After this fire plans were worked out to enclose the main drives with partitions of a fire retardant character, so as to approximate the standard belt tower with brick walls, such as are found in many mills of modern design.

11 The limitations of cost, available space, etc., which prevail in many places where the belt tower is not a part of the original design, make necessary special construction such as was adopted in this case, and has been successfully used in many others of the older mills.

12 The plan provided for inclosing the main drives with partitions of expanded metal and cement construction from 2 in. to $2\frac{1}{2}$ in. thick depending on the story heights. A framework is constructed of expanded metal wired to 1 in. or $1\frac{1}{4}$ in. channel iron studs spaced 12 in. apart, and secured to the floor and ceiling. Longitudinal stiffeners of the same material as the studs are used. Where necessary, as in the case of a continuous partition of more than 10 ft., additional stiffness is secured by providing $2\frac{1}{2}$ in. tee-bar uprights. On the frame so constructed portland cement mortar is applied by plastering to make a solid partition, all of the iron frame being embedded in the cement with the exception of the door jambs. These partitions, being comparatively light in weight, could be set up anywhere on the heavy mill floors without the necessity of strengthening them, al-

though where possible it was arranged to have the partitions come over the beams. Although this form of construction for partitions has been largely used and with satisfaction, it would be possible of course to employ some of the special forms of studding now on the market which combine the studs and lathing in one sheet of metal. Details of the construction used are shown in Fig. 3.

13 While in general the enclosures occupy only the floor space necessary for the main belts, it was endeavored to have them as

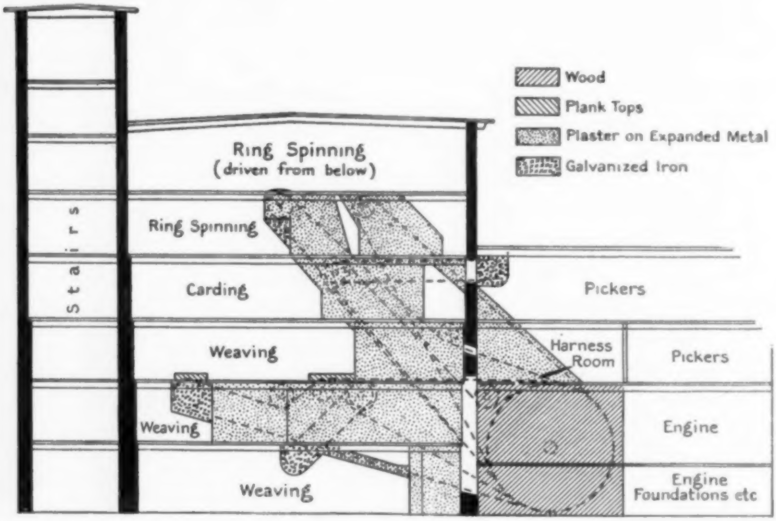

FIG. 4 SECTION SHOWING MAIN DRIVE AS NOW PROTECTED BY FIRE RETARDANT ENCLOSURES

roomy as conditions of machinery installation would permit, in order to facilitate inspection and repairs to the main belts. Provision was made for taking down the lineshafting without disturbing the body of the partitions, usually by placing the fire doors which gave access to the enclosure under the lineshaft, and providing removable wood tin-clad panels constructed like fire doors above the latter. The main bearings were generally left outside the enclosures and to accomplish this the panels in front of the pulleys were sometimes recessed.

14 It was also the endeavor to arrange these enclosures so that they would be as well lighted as possible by including in them windows in the side wall of the building or providing wired

glass windows in metal frames to admit light to the beltway from the room. Fig. 4 shows diagrammatically the completed work at the Fall River mill, and Figs. 5, 6, 7 and 8 are photographs of belt enclosures in different stories. The adaptability of the construction is evidenced in the sloping sides and offsets which it was necessary to make in many cases on account of crowded conditions in the vicinity of the main belts.

15 While there is no claim that these partitions are as efficient in withstanding the action of a severe fire as a brick wall would be, they are undoubtedly effective in preventing the dangerous draft up through an open beltway. In an actual fire in one of the mills where this construction was installed these enclosures were successful in confining the fire to narrow limits, and undoubtedly prevented a very serious loss.

16 *Stairways.* Where interior stairways are not properly enclosed in brick towers, it is possible to improve the conditions with enclosures of the same type of construction as employed in the beltway work, although it would be much better where the appropriation can be secured to build a standard tower of brick or concrete, especially if the mill is of any considerable height. Placing the stairs and elevators in towers projecting from the mill wall frequently results in a gain of valuable floor space.

17 The type of stair tower that has been developed in the factory buildings at Philadelphia is deserving of more general adoption as it combines with its functions of a stair tower that of a fire escape in the best sense. It consists essentially in a tower separated from the mill so that access to it can be had from the several floors of the mill only from an outside platform or from a vestibule which is open to air. Such a tower can never become filled with smoke from a fire in the mill. Many of the older mills in other sections of the country have stair towers that can be readily converted into towers of the Philadelphia type by closing the openings between the stair tower and the mill in the several stories and arranging for an outside platform in each story communicating from the mill to the tower.

18 *Elevator Enclosures.* We have also found the use of expanded metal and cement partitions practicable for enclosing elevator wells that were not properly protected in the original construction of the building, or where they have since been added. The necessary openings at such elevator shafts should be closed, preferably with wood tin-clad doors of the type which serve as

safety gates as well. Where space does not permit of the installation of such doors, rolling steel shutters arranged to be automat-

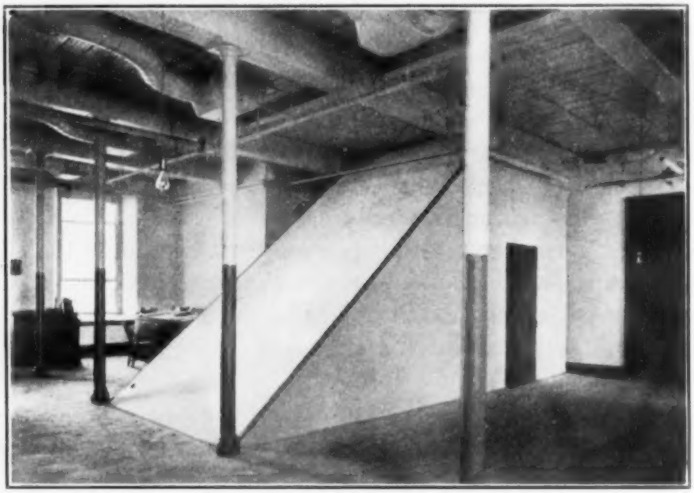

FIG. 5 HARNESS ROOM, SECOND STORY, DIRECTLY OVER FLYWHEEL SHOWING PROTECTION OF BELTS LEAVING WHEEL

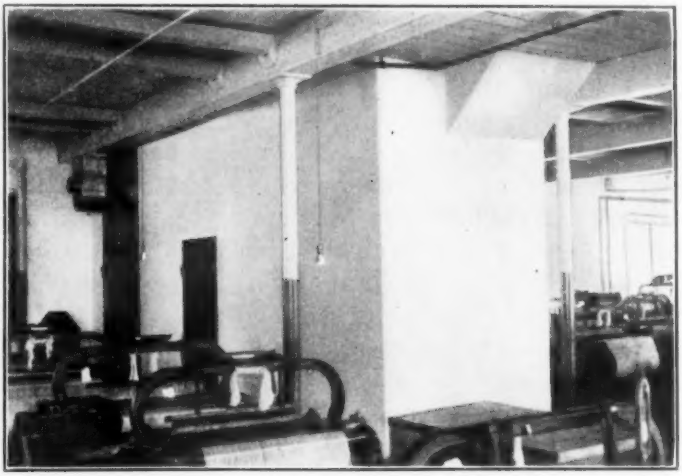

FIG. 6 WEAVE ROOM, SECOND STORY. NOTE FIRE DOOR WITH REMOVABLE PANELS ABOVE TO ALLOW ACCESS TO PULLEY ON LINESHAFT

ically operative by the melting of a fusible link, as well as manually, can be used providing the hazards of occupancy are not excessive.

19 *Other Uses.* The average cost of partitions of the construction advocated is from 30 cents to 33 cents per square foot.

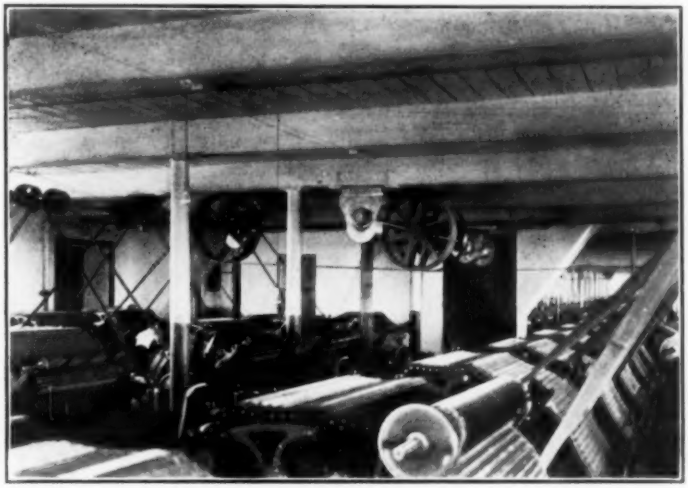

Fig. 7 Card Room, Third Story. Ends Sloped to Economize Space. Note Wire Glass Window and Fire Door with Removable Panels above

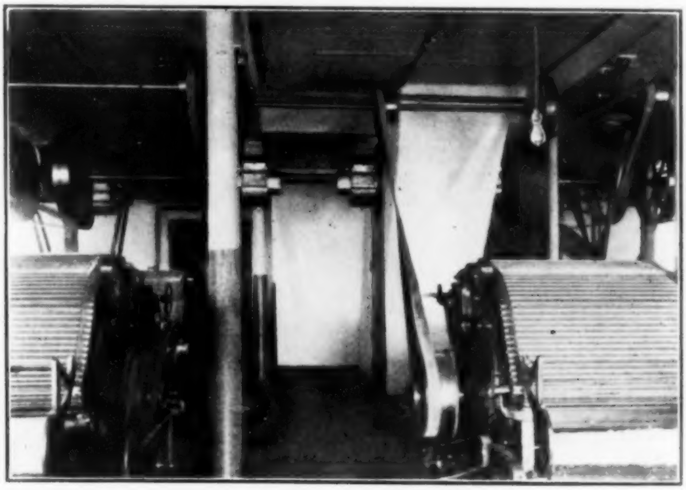

Fig. 8 Card Room, Third Story. End View of Belt Enclosure. Bearings All Outside

These figures are for the work in place and include a contractor's profit. These partitions have been used with superior results and

not greatly increased expense over ordinary forms of combustible construction for the purpose of separating special hazards from the remainder of a manufacturing room. For such purposes as the construction of bins to contain inflammable stock, the segregation of waste working machines, construction of lacquer rooms, etc., uses are constantly being found for this material in manufacturing works.

THE LIFE HAZARD IN CROWDED BUILDINGS DUE TO INADEQUATE EXITS

By H. F. J. Porter

ABSTRACT OF PAPER

Some seven or eight years ago the writer endeavored to empty a non-fireproof crowded factory building by a fire drill and found to his surprise that a stairway, when the attempt was made to use it by a large number of people entering it simultaneously at different stories, had a very limited capacity. He was unable to empty the building until practically a separate stairway from each story was introduced, and then the stream of people occupying each story flowed into its own stairway at the top and out at the bottom without colliding with any other people on their way down.

The loft factory buildings have so many stories that it is impossible to supply separate stairways for each story; consequently, some other method of giving safety to the occupants in case of fire must be adopted. The fire wall, bisecting these buildings from cellar to roof, allows all the occupants on one side of the wall to pass through the wall and to close the door, thus emptying that side of the building, which may be 20, 30, 40 or 50 stories in height, in less than a minute.

THE LIFE HAZARD IN CROWDED BUILDINGS DUE TO INADEQUATE EXITS

By H. F. J. Porter, New York

Member of the Society

Buildings in general are either non-fireproof or fireproof. The former can be compared to a pile of kindling wood out in the open, sometimes oil soaked and always ready to be set on fire. The latter are comparable to a stove full of fuel ready to be set on fire. In both cases the human occupants swarm around in the interstices in the pile of fuel, and as soon as the fire starts those caught in the fagots have to work their way down through the smoke and flames to the ground to save their lives.

2 Factory buildings in particular are sources of great danger to their large number of occupants, both on account of their non-fireproof construction and because of the obstructions to rapid egress, due to haphazard placing of machinery, furniture and partitions and the small number, size and character of the exit facilities.

3 Of late, there has been advocated the unrestricted use of fireproof construction in the buildings themselves and the author has recommended the development of a form of exit drill of the occupants of each building to determine if, in the case of danger, they could escape readily from the building and if they could not, the alteration of the exits until they could. By "readily" is meant within 3 minutes, for from many conferences it was found that people do not want, nor would it be safe, to remain in a burning building longer than that time.

4 The capacity of a stairway, if time is not a factor and a stream of people pours into it only at the top and out of it from the bottom, is unlimited; but if time is to be considered the capacity is limited by its cross-sectional area. In a multi-storied building with crowds of people on each floor trying at different points in its length to get on to one stairway in a limited time,

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the conditions are very different. If more people try to get on to the stairs from each floor than the section between that floor and the floor below will hold, a jam will occur so that the flow downward will cease. The capacity of this section is very limited.

5 A crowd of people does not flow like a liquid composed of round smooth molecules. Their soft bodies are angular in shape more like pieces of rubber with wires in them and they therefore interlock. Clothes present rough surfaces causing friction and if the stairway is narrow an arch is apt to form across it which can become an obstruction in case of pressure from above such as actually to burst the stair rail or enclosing partition.

6 The capacity of a stairway of the average height of from 10 to 12 ft. between floors and not less than 22 in. wide would be one person on every other step or 10 and 12 per floor respectively, and if the width is doubled (not less than 44 in.) so that two people can come down abreast, twice those numbers or 20 and 24. If a stairway has winders in it, its capacity is reduced 50 per cent. One person can descend a single flight of such steps 10 to 12 ft. high in 10 seconds, striking a gait which he can maintain for seven or eight flights of steps. After that he goes slower, making the tenth flight in about 11 or 12 seconds. Every person added in single file adds 1 second to this time. A double file takes no longer if the stairs are double width. Thus it will take 10 seconds for 10 or 20 people, that is, the full capacity of a flight of steps, to come down one story. The capacity of a stairway may be thus increased by widening it in multiples of 22 in. A crowd of people cannot be depended upon to come down more than ten stories. One or more of them will give out, and demand the attention of others. Those who do get down will be severely taxed. The total time required to empty a building is determined by the time required to empty either the floor farthest from the ground or the floor occupied by the greatest number of people.

FORMULA FOR EMPTYING A FLOOR BY ONE STAIRWAY

Number of couples (number of people divided by 2)	c
Time of formation in line after signal, seconds	10
Time one couple takes to march to top of stairs, seconds	10
Time each couple takes to pass through door at top of stairs, seconds	1
Number of stair flights (one less than number of floors)	f
Time of one couple to descend one flight of stairs, seconds	10
Time of one couple to go from foot of stairs to street, seconds	10

$$\text{Total time} = T = 30 + e1 + f10$$

Example Time of empyting 100 people from tenth floor

$T = 30 + 50 + 90 = 170$ seconds $= 2$ minutes, 50 seconds

Example Time of emptying a ten-story building with 20 people on each floor is the same as emptying 20 people from tenth floor

$$T = 30 + 10 + 90 = 130 = 2 \text{ minutes, } 10 \text{ seconds}$$

7 Tests of the capacity of fire escapes in a limited time gave the following results: A straight ladder, 2 per floor; ladder set at 50 to 60 deg. with the horizontal requiring people to go down backwards 3 to 4 per floor; stairs 30 in. wide, 10 to 12 per floor; and the modern outside stairway with a mezzanine platform 40 in. wide, 20 to 24 per floor, the same as an inside stairway. Fire escapes are usually so exposed to flames from windows opening upon them that they are more often fire traps than fire escapes. They should be prohibited by law and safer methods of escape provided.

8 In order to insure the safety of the occupants of a building in case of emergency one of two things has to be done: (*a*) there should be two stairways so that if one is cut off by flames or smoke the other can be used and the number of occupants reduced on each floor to meet the limited capacity of the part of the stairway between floors, or (*b*) the number of stairways increased so as to have two separate and independent stairways from each floor to the ground with its own exit from the building. People can then pour into the top of whichever one is not cut off by the fire and continue down and out at the bottom without colliding with those from any other floor. Fire drills installed under either of these conditions worked more or less satisfactorily, and the author tried unsuccessfully for years to have ordinances passed in New York City and legislation enacted at Albany, making them mandatory, but the expense of changes in the buildings and the idea of having employees walk out of a factory while manufacturing operations were under way, upon the sounding of an unexpected signal, did not appeal to factory proprietors as practical. It required holocausts in New Jersey, Pennsylvania and New York finally to bring about the legislation in those states.

9 As time passed, however, the author developed what might be termed an exit test in factories which presented the opportunity and found to his astonishment that almost without excep-

tion, exit facilities adequate for handling the regular number of occupants under emergency conditions, were lacking.

10 This situation has probably developed with the rapid growth of industry where a factory building had been built to accommodate a certain number of people, and then, as the business grew, more people were accommodated without realizing that each additional person became an increment of danger to all. Or, if the danger was at all appreciated, some means of escape from windows was supplied which might be anything from a rope to a ladder. After this condition had become general it crystallized into custom, and new buildings with exit facilities inadequate for their occupancy were designed, erected and accepted as safe. Ropes were followed by ladders, and these in turn by fire escapes which became in time an established necessity.

11 Engineers, when called upon to supply a mechanism, are expected to have it subjected to a working test, which it must pass before they get paid for it; but architects and builders have never been called upon to demonstrate by actual test that the facilities which they have supplied in their buildings for the purpose of emptying them under emergency conditions will actually work, and this notwithstanding repeated instances of panic congestion on stairs, of people being burned to death on fire escapes, of elevators sticking from the warping of their runways from heat, etc.

12 When subjected to test these exit facilities in many buildings have been found to be entirely wanting in adequacy, and when this fact was brought to the attention of those who were responsible, it has been surprising to find how readily they accepted the criticism. On the other hand, those who possess these unemptiable buildings are skeptical of such statements and unwilling to be persuaded that the buildings are not safe. They point to all the other buildings erected by reputable architects and builders and naturally are incredulous.

13 In order to empty these buildings, additional stairways had to be built and fire drills developed to take the people out. Such changes in the building are expensive, for two stairways have to be installed from each floor to the ground, so that if one is cut off by a fire, the other can be used. In many-storied buildings the number of stairways required becomes impractical. In addition fire drills are expensive to operate, for they involve not

only loss of time of operatives and a break in the continuity of the process of manufacture, but the actual going down stairs and return of people, some of whom may be lame, others affected by weak hearts or lungs, others anaemic or organically weak, reduce the efficiency of the working force for a very appreciable time. If the drill takes place at the end of the day this criticism might be modified slightly.

14 Such is the situation in the usual type of factory building to be found in the average town where ground is cheap, buildings large and stairways broad. Turning now to the loft building used for factory purposes, the conditions as regards emptiability are found to be very much worse and have to be corrected in a different manner.

15 Let us consider for the moment a one-story or ground-floor factory building with a doorway at each side, one of which is cut off by a fire. The people can march out horizontally through the other doorway and nothing will impede this horizontal exit except the size of the doorway. If this is 22 in. wide, a single file of people can pass out in an orderly manner at the rate of one person every second. If it is 44 in. wide, a line of people two abreast can pass out in the same time. One hundred people can make their exit through one 44-in. door, therefore, in 50 seconds, or say one minute.

16 Now put another factory on top of this one with one hundred people in it. The doorway at each side will have to open on stairways which lead down to the doorways constituting the exits from the factory below. Suppose a fire occurs on the floor below, cutting off one of these exits, the 100 people on the lower floor immediately proceed to make their horizontal exit, while those on the upper floor proceed to make a vertical downward exit to reach the doorway out of which those below are moving. The result is of course a collision, the stream of people from upstairs coming down upon the stream of people on the ground floor on their way out. This collision prevents both the up-stairs stream from coming down and the down-stairs stream from going out. There is a complete lock, and the building does not empty.

17 Not only have we put one factory on another in the case of our loft building, but we have piled factory on factory until we have from 10 to 30 and more, one on top of the other; and each employing from 100 to 300 or more people. In cases of

emergency as in the Asch Building fire, there are only two courses for the occupants: one is to burn to death, and the other to jump to death—" to burn up or jump down."

18 It is impossible to reduce the number of people per floor to the capacity of the stairs, say 24 per floor. Even if that number would be all that a business required, in case of emergency they would have to go down stairs, and it is a physical impossi-

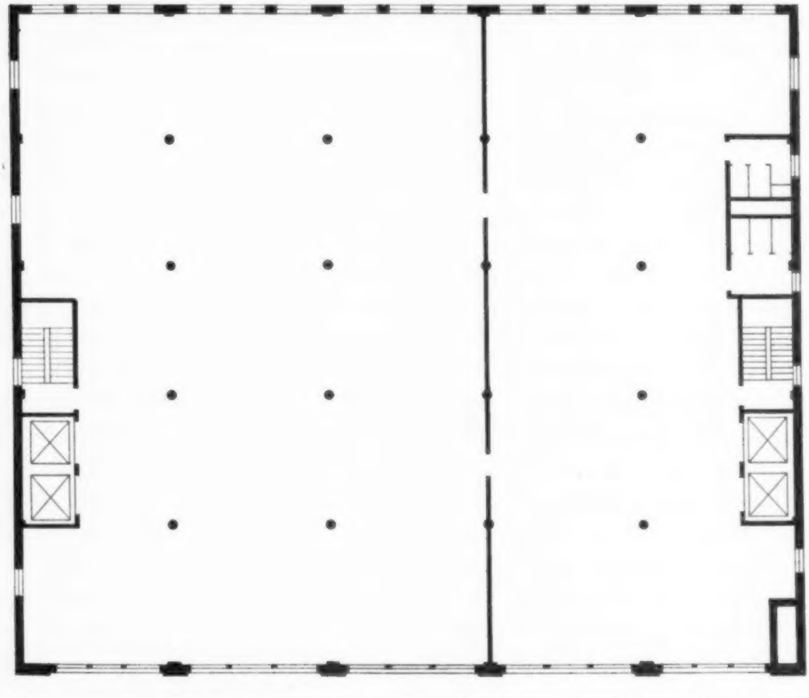

Fig. 1 Floor Plan of Typical Loft Building Showing Fire Wall with Doorways

bility for people to stand the exertion of a trip down more than ten stories without resting; and when they stop to rest they block the stream and obstruct its exit. Under these circumstances it is necessary to develop some other method for people in high buildings to secure safety. The following suggestion is offered to meet the situation:

19 It has been seen that a horizontal escape by people on the ground floor is readily secured. Let us see if a horizontal escape to safety for people at any height from the ground can be devel-

oped. Suppose a wall is built across the building from cellar to roof practically bisecting it in a way so as to have a stairway and elevator on each side. This wall should have at least two doorways in it at a considerable distance from each other and closed by self-closing fireproof doors (Fig. 1).

20 It is improbable that a fire will occur on both sides of this wall simultaneously. It could occur only by incendiary origin, and that would hardly be possible in working hours. Should one occur on either side, the people on that side would go through the doorways in the fire wall, close the doors after them and be perfectly safe. That half of the building in which the fire might be should be emptied in less than a minute if there were no more than 100 people on each floor to pass through one doorway 44 in. wide. If the principle of the horizontal escape presented by the fire wall is included in the design of new buildings a most satisfactory method of securing safety at comparatively small expense will be offered.

21 In every way possible the horizontal escape should be developed in old buildings and the vertical escape subordinated. Factory buildings adjoining one another may have doorways through their sides connecting them on various floors closed by fireproof self-closing doors, or may be connected by outside balconies built around the party walls; or, if of different heights, doors in the sides of one may lead out on the roofs of the others.

22 The fire wall bisecting the building as described makes practically two buildings, each provided with elevators and stairways. A fire on one side of the wall would be confined to half the building, and therefore the property loss would be reduced one-half. Only one-half the people would be endangered and have to move, and the distance they would have to go would be only one-half what it would be if they were on the ground floor of a building without a fire wall. They could remain on the same floor till the fire was extinguished, or could go down to the ground by the elevators operating under normal conditions.

23 The fire wall eliminates the necessity for a fire drill with its accompanying objections. Of course all buildings occupied by many people should have a fire alarm signal system in them to advise the people promptly of their danger. In buildings where there is a fire wall the signals should be arranged so that in case a fire should occur on one side of the fire wall on any floor, a bell on each floor on the same side of the fire wall would

ring, indicating on which floor the fire is. Then all the people on that floor and above it should pass through the fire wall and close the doors. Those below need not disturb themselves until the fire threatens them, and then they too can pass through the fire wall.

24 There are certain other safety devices which should be supplied in factories to protect the lives of the operatives from fire. One of these is metal-framed windows with wire glass. These are made so as to close automatically in case of fire, thus preventing the latter from spreading upwards from floor to floor outside side of the building.

25 Another safety device is automatic sprinklers which serve

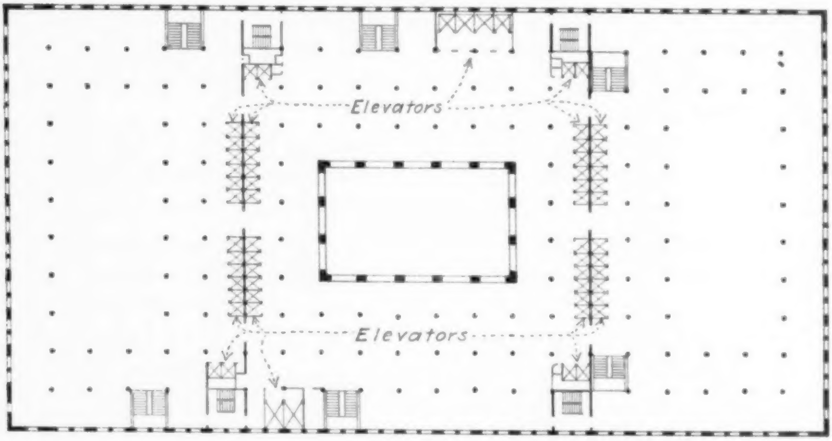

FIG. 2 DEPARTMENT STORE FLOOR PLAN SHOWING PRESENT ARRANGEMENT OF FIRE WALLS, ELEVATORS AND STAIRS

to extinguish fires in their incipiency. All doors should be made to swing outward, and where they open on a hall or stair landing they should be vestibuled, so as not to obstruct the passage way. Sliding doors should be avoided if possible, as they are apt to stick or jam by pressure of people upon them.

26 Each floor of our typical loft buildings is say 100 ft. by 100 ft. by 10 ft. and therefore contains 100,000 cu. ft. of air. The laws of New York and many other states require 250 cu. ft. of air per person as a limitation of occupancy. This limits the number of people per floor in a building of this size to 400 and if the stairways were 44 in. wide (and there are none now over

36 in.) at most only 40 per floor could possibly go down them even if the other 360 would let them.

27 With the fire wall only 200 of the 400 people on each floor would have to move, and if there were two doorways in the fire wall at some distance from each other, they could reach safety through them in one minute, or if one were cut off by the fire, all could pass through the other easily in two minutes. More doorways can be introduced, and thus the time of exit could be lowered still further.

28 An effort is being made to increase the amount of air space required per person from 250 to 500 cu. ft., which would reduce the number of people per floor to 200, of whom only 100

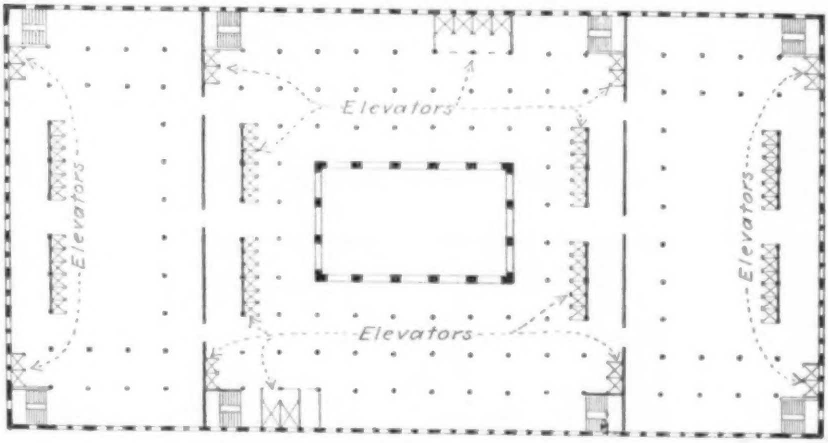

Fig. 3 Suggested Arrangement of Fire Walls, Elevators and Stairs for Department Store

would have to move, and they could easily reach safety in one minute.

29 The stairways and elevators should be inclosed in fireproof walls to prevent a fire on one floor continuing upward and setting the other floors on fire. The ceiling of the basement where the machinery is located should be fireproof, and should not be pierced inside of the building, so that a fire there would not reach the elevator shafts.

30 Fire escapes which are simply stairs and possess dangerous features not only of limitations as to size, but of accessibility for flames and smoke, should be looked upon as evidence of the

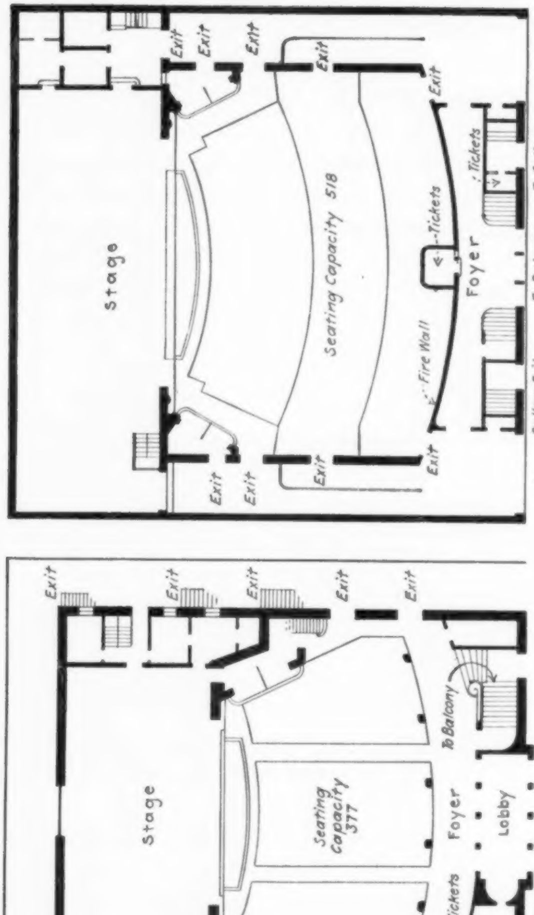

FIG. 4 TYPICAL AND PROPOSED THEATER PLAN SHOWING USE OF FIRE WALLS, SIDE ENTRANCES AND EXITS

incompetence or ignorance, or worse, of the architect, builder, or owner, and prohibited by law under a heavy fine. They are not only dangerous to life by giving a false confidence in their adequacy for escape, but they destroy the appearance of the building. Our cities should be built without such architectural blemishes.

31 Fire escapes of the chute type are tubes with a smooth helix instead of steps. If the only opening is at the top they have considerable capacity. They soon rust, however, and at best are not to be considered seriously in comparison with other means of safe exit. People cannot enter them at different floors while a stream of people is passing down from above.

32 The smoke-proof tower, claimed to have originated in Philadelphia, is the latest improvement in the line of fire escapes. It is simply an enclosed stairway on the outside of a building, but cannot be reached except by going out of doors. Its special claim is that smoke and flames cannot get into it. It has, however, no more capacity than any other stairway, and as its approach is always open to the weather and its interior is always more or less dark, it is never used in ordinary service and becomes neglected. These monuments to architectural incompetency can be seen here and there filled with the dust and accumulated rubbish of every unused open space. When a time arrives for using them everybody has forgotten their existence. During the last year or two, notwithstanding the protests of many, a great many new buildings have been constructed, especially in New York City, with these monstrosities on them, and have been accepted by the Building Department in all seriousness.

33 The fire wall should be introduced into all buildings where the public congregates in large numbers. Large department stores, which on certain days are said to accommodate several thousand people per floor, are very dangerous places at present. A fire, or a panic without a fire, might cause a fearful tragedy. It is criminal for their owners to object to fire walls and offer as an excuse that they would obstruct the vista. Certain cities require fire walls in such buildings now as a property protection, and the vista is dispensed with without comment. The department stores of Philadelphia are so divided; John Wanamaker's new store there is divided by two such walls as shown in Fig. 2. The exit facilities in it, however, are badly

arranged, for the architect apparently did not think of the life hazard of its occupants, and designed the fire walls to protect property only. Fig. 3 shows how the building might be redesigned so as to be safer. It should be noted that the elevators are removed from the fire wall so that people trying to go down in them would not block the doorways of the fire wall and prevent others coming through them. The stairways are situated as far from the fire wall as possible and should be enclosed by fireproof partitions.

34 Churches, assembly halls and similar ground-floor buildings should have their floor fireproof and unpierced so that any fire occurring in the basement would not endanger the occupants of the main building.

35 Moving picture buildings, theaters, etc., should be redesigned (Fig. 4). People come out of them by the way they go in, and in case of emergency all crowd into the narrow aisles. These aisles should be turned across the room and lead directly to courts opening on the street in a way such that streams of people will not collide. The various balconies and galleries should have foyers behind fire walls with separate stairs and street exits so that patrons will not have to mingle with those making their exit from the lower floors.

36 Every school building should be divided by a fire wall providing a horizontal exit on each floor, so that the children will not have to be drilled to go down stairs in case of fire.

37 Hospitals where the inmates are bedridden, blind, lame, invalid, imbecile, or otherwise helpless, can be made safe by the introduction of the fire wall between wards, and in case of fire those who are bedridden can be wheeled on their beds through the doorways, and those who are up and about can walk through them.

38 Hotels and apartment buildings can so easily have a fire wall developed in them that it need only be referred to here in passing. Even the private residence where only a few people occupy a floor can be made safe in this way. The back stairway should be enclosed in a fireproof partition, and in case of a fire instead of everybody having to go down stairs through the smoke and flames, or having to jump from windows, the people on each floor have simply to pass through the fireproof door and go down stairs in safety. In large residences where there is a servants' quarters in connection with the back stairs, the build-

ing would be bisected and the people on either side of the wall would be able to carry their clothing and perhaps much household and personal property to safety.

39 Two years ago the National Fire Protection Association appointed a committee of which the author was a member to draft suggestions for the organization and execution of fire drills. This committee made its report to the annual meeting of the association held in Chicago last May, and it was adopted with slight modifications. A prefatory note to this report is as follows:

> Many so-called fire drills, outside fire escapes, and similar practices and devices are generally insufficient, often dangerous, and therefore misleading substitutes for rational exit facilities, and are a manifestation of improper design and construction of our buildings. A stairway connecting many stories will accommodate only a limited number of people. Stairways are, therefore, dangerous means of exit for crowds. Congestion is bound to occur in them when used under stress of excitement owing to their limitations.
>
> The primary object of the exit drill is to determine if the building is properly designed so that in the emergency of a fire its occupants would be able to effect their escape readily without the probability of injury from stairway or other congestion which inevitably causes panic. This test should be occasionally repeated to insure the continuous maintenance of safe conditions.

40 The author advocates legislation, requiring (*a*) that architects and builders be prohibited from designing buildings which cannot be emptied within 3 minutes after a given signal; (*b*) that the municipal authorities be required to institute an exit test in each building to determine, before it is accepted, if it can be emptied of its occupants in 3 minutes. If it cannot pass this test it will not be accepted and must be altered until it can pass the test. (*c*) Afterwards the proper authorities will be required to repeat the exit test from time to time, to see that the safe conditions originally established are maintained.

PRACTICAL OPERATION OF GAS ENGINES USING BLAST-FURNACE GAS AS FUEL

BY CHARLES C. SAMPSON

ABSTRACT OF PAPER

The paper discusses the following features upon which the operation of gas engines using blast-furnace gas as fuel depends: present methods, improved apparatus, gas mains, suggested improvements in scrubber designs, gas regulation, protection from freezing, signal systems, protection from explosions, and the value of operation records.

Under the engines themselves are considered the operators, air starting system, water jacket cleaning, cylinder oil, engine oil and engine oil systems, ignition and prematuring.

PRACTICAL OPERATION OF GAS ENGINES USING BLAST-FURNACE GAS AS FUEL

By Charles C. Sampson, Joliet, Ill.

Member of the Society

The question of the operation of gas engines using blast-furnace gas as fuel includes several important factors outside the actual operation of the engines themselves. It will therefore be aside from the present purpose to do more than state that the usual blast-furnace gas has the following composition:

	Per Cent
Carbon monoxide	23
Carbon dioxide	12
Hydrogen	2
Methane	2
Vapor of water	3
Nitrogen	58

and a calorific or heating value of about 900 cal. per cu. m., and gives a consumption of 3 cu. m. per i.h.p. in the engine.

CLEANING OF THE GAS

2 One of the most important of these factors and one which held back the general use of these engines many years is the cleaning of the gas. As delivered by the furnaces to the downcomer the gas contains normally from 3 to 10 grains of dust per cubic foot of dry gas, but at times of slips or other sudden changes in the furnace, it carries much more. For use in engines the gas must be cleaned at most to 0.02 grains of dust to satisfy the requirements of the engine builders, but even this figure is too high to satisfy the operating engineer since it is possible to clean the gas to 0.005 or 0.006 grains per cu. ft. with great benefit to the engines.

3 The method of cleaning most used at present has three stages: (*a*) dry cleaning to 1½ to 2 grains per cu. ft. which is

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always done by the blast-furnace department; (*b*) primary washing in static washers to about 0.15 grains per cu. ft.; (*c*) dynamic or mechanical cleaning in highly developed machines to 0.015 or less. The last stages are usually handled by the gas-engine departments, though as the furnace men realize more and more that a cleanliness of 0.2 grains per cu. ft. or less is of great benefit to the stoves and boilers they will take over the second stage, leaving only the final cleaning for the gas-engine department.

4 The dry cleaning is done in dry dust catchers, the standard design being a large diameter, vertical, cylindrical shell into which the gas enters tangentially near the top and leaves through a vertical outlet pipe which extends about two-thirds down from the top. These dust catchers remove the heavier particles of dust, but their efficiency is only about 80 per cent as they pick up, or perhaps do not drop, the finer dust which is carried on by the upward current of gas to the outlet.

5 The refinement of design in dry cleaners has advanced materially in the past three or four years, as shown in the modern apparatus resulting from the careful study of the problem. One of the latest of these is the centrifugal dust catcher shown in Fig. 1. This device makes use of the centrifugal separation of dust from the gas as it passes inward through a cylindrical spiral opening into a dust basin at the bottom. The gas enters at the top of the outside, leaves at the top of the inner end of the spiral and passes upward through an extension of the pipe around which it is wrapped. The gas passes free of all obstructions at the upper end of the spiral while the dust separated drops to the bottom through the open end. There is no tendency for the gas to pick up the separated dust and carry it out as is the case in the older types of dry cleaners.

6 It is frequently found that sudden changes in the direction of flow of the gas, as at water seals or other necessary bends in the pipe, are quite efficient in the removal of the dust. In one case gas carrying about 5 grains per cu. ft. passed through four sharp bends and gave all dust but about 2 grains per cu. ft. For this reason every part of the dry gas main where such bends are necessary can be made to assist materially in the cleaning of the gas, if pockets are added equipped with valves so that the dust can be conveniently removed.

7 Where long gas mains are necessary they can be made to add to the cleaning of the gas by building them in successive

lengths with sufficient rise and fall to allow the dust to settle in pockets at the bottom angles for cleaning. If the gas for any reason moves slowly in a long main the loss of heat through the pipe will probably reduce the temperature below the dew point and thus condense some of the moisture carried with the gas from the furnace and cause the deposit of wet dust which adds

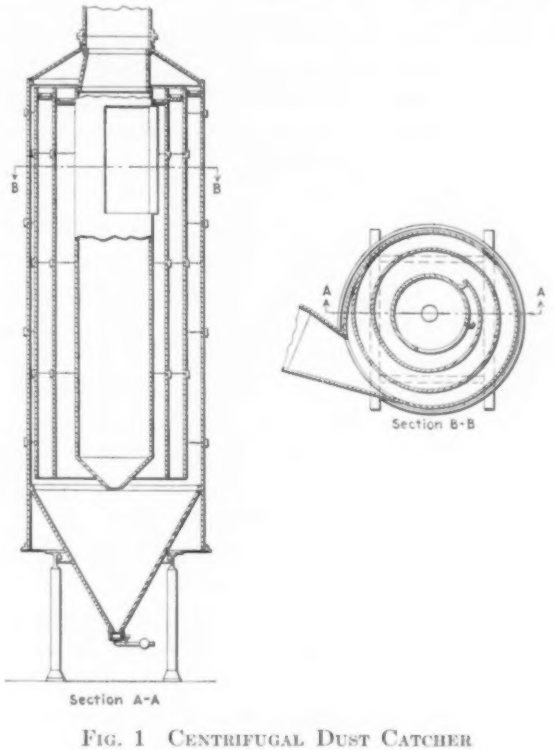

FIG. 1 CENTRIFUGAL DUST CATCHER

greatly to the cleaning plant labor. This is especially apt to occur where two or more groups of furnaces supply one washing plant; the gas from the one with the lower top pressure will move slowly or even reverse its direction of flow at times, allowing excessive cooling and the resulting condensation. This condensation will begin when the temperature is reduced to 115 deg. to 120 deg. fahr. and will of course give more trouble in winter when the condensed moisture will freeze in the dust valves and drips and require continual thawing to allow its removal.

8 It is possible to keep the gas mains clean without taking them out of service if they are equipped with sufficient openings

to allow every part of the pipe to be reached with a stream from a high-pressure water system, and with valves or doors at all low points for the removal of the mud washed down. The mains near the furnace of course do not need this equipment as they can easily be designed to make them entirely self-cleaning, while it is quite necessary that long mains where condensation may occur be so equipped.

9 The present primary washers (the first stage of wet cleaning) are of the static scrubber type and include all those in which the gas passes through a stationary shell without moving parts, the water for washing being supplied either in spray or sheets. The spray and hurdle, Mullen, baffle, and rain type scrubbers come under this classification.

10 The spray and hurdle system is preferred on account of its better distribution of water, and since it is self-cleaning it needs inspection only after long periods of operation. Several of these scrubbers have been opened after from one to three years' service and in every case have been found perfectly clean and required no repairs whatever before being returned to service. The wood was in good condition as it is continually wet and oxygen does not have access to it to start decay. In the rain or baffle types the gas is more apt to channel and travel up one side of the scrubber and the water down the other.

11 It is important to secure uniform distribution of the gas as well as of the water in any scrubber. For the inlet a cone about two-thirds the diameter of the shell with a cone-shaped ring below it open in the center about one-half the diameter of the shell will give good distribution. These should both slope about 45 deg. to keep the mud from remaining on them.

12 Two outlets at opposite sides of the top are better than one on account of the deflection of the water by the gas currents if only one is used. This is particularly true if the water is sprayed by falling on spray plates as the gas current may then be strong enough to blow the water clear of the plate and thus entirely lose its effect. Spray nozzles are not subject to this fault but are not able to handle water that has much dirt in it without a great amount of attention.

13 In designing the scrubber bottom, its foundation and the basin and overflow for the outlet water, it must be remembered that while the usual working pressure will be from 6 in. to 18 in. of water, a slip will give pressure of from 40 in. to 50 in. for

a short time. A normal head of water of 36 in. from the bottom of the scrubber to the water overflow level with the basin walls 24 in. above this and an emergency overflow 4 in. below the top of the basin walls will care for slip pressure without blowing out any gas or overflowing the basin into the yard. The bottom of the basin wall will be self-cleaning if it has a steep slope and the outlet pipe is from the center of the bottom. The whole design of scrubber and basin must be examined to eliminate all

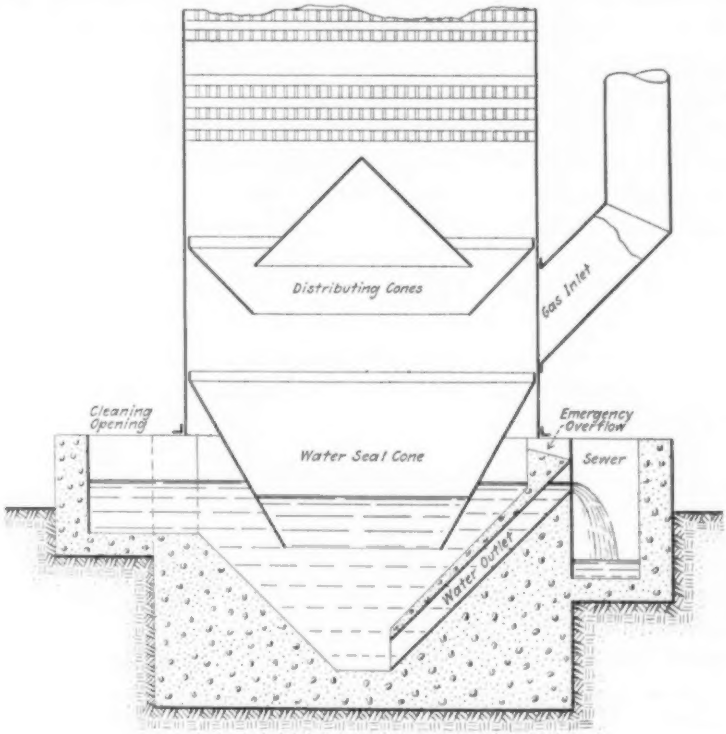

Fig. 2 Scrubber Bottom

places where mud can remain long enough to cake. Fig. 2 shows this arrangement of scrubber bottom.

14 Should the water overflow pipe be stopped even for a short time the heavy mud will settle to the bottom of the basin and when the overflow pipe is cleaned there will be such a quantity that even the extra head of water to the emergency overflow will not force it out. For this reason the forming of heavy chunks must be prevented as much as possible and provision must

be made for stirring the basin water both with hoes or rakes and with a stream of water from the end of a pipe which can be thrust into all parts of it. It will be found convenient also to have the pipe bent at the end so that the stream can be directed up the overflow pipe to furnish additional head for starting the flow when necessary, or a special pipe with return bend and short nipple to thrust down the overflow pipe itself will surely be able to start the flow.

15 The final stage in cleaning is done with mechanical scrubbers or washers. These are highly developed and the Theisen patented gas washer has been in the lead for several years though other types are now being worked out, their builders claiming better results with less water and power consumption than the Theisen. The Theisen washers require about 3 per cent of the power-plant output for their operation and from 16 to 18 gal. of water per 1000 cu. ft. of gas cleaned, which added to the 75 to 80 gal. required in the scrubbers makes the total from 90 to 100 gal. for the whole cleaning process. The newer apparatus, which are along the lines of the mechanical disintegrator, claim to use about 20 gal. of water per 1000 cu. ft. of gas for the whole cleaning process and to operate on less power than the Theisen washers.

HOLDERS

16 In blast-furnace gas-engine plants the engines are entirely dependent upon the continuous supply of gas from the furnaces; a 100,000-cu. ft. capacity holder can only be considered a pressure regulator with capacity for enough gas to allow retiring in good order when the gas supply is cut off for any reason. Thus in a 1000-kw. plant with such a holder the gas on hand would operate the plant only for about 25 to 30 minutes and should not be counted on for more than 15 to 20 minutes. This in an emergency would give time to notify the various departments using power and allow them time to prepare for a shutdown.

17 The quantity of gas consumed by the engines is regulated by the governor to suit the power output, but since they must be supplied with gas at uniform pressure for satisfactory operation, it is necessary to regulate the gas supplied by some type of gasometer. This is best done by a gasometer of capacity such that the pressure fluctuations are not noticeable at the engines, and since it is well to have an emergency quantity of gas the gas holder itself will meet both demands at once if supplied with

an efficient regulation valve. The holder will regulate the pressure perfectly between the maximum limit of the total quantity of gas that can be forced through the mains with the furnace pressure available assisted by the gas washers and the minimum limit of the leakage at the regulating valve.

18 There should also be the possibility of regulating the gas quantity at the secondary washers since at times of very light loads the gas pressure between the holder and washer may blow out drip seals or cause dangerous gas leaks. This can be cared

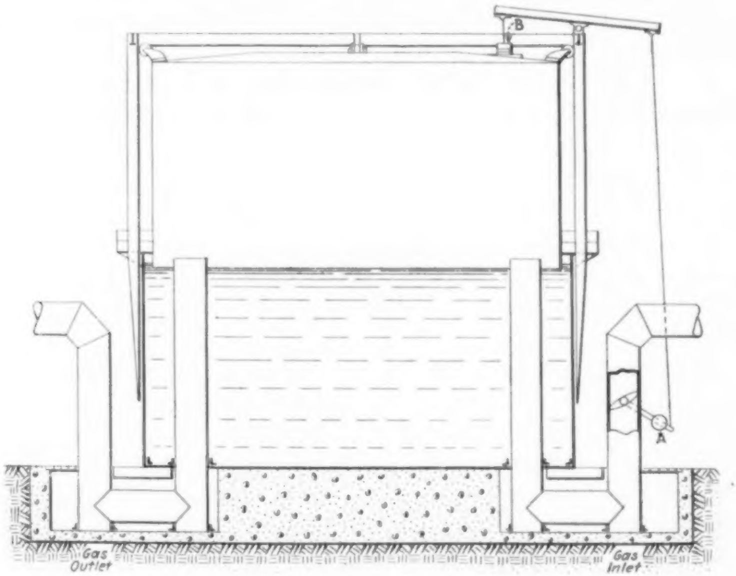

Fig. 3 Arrangement of Regulating Valve for Gas Holder

for by the installation of butterfly valves with quadrants either before or after the mechanical washers. The latter is to be preferred for then the gas remains longer in the washers and receives additional cleaning.

19 A good regulating valve at the holder is a butterfly valve attached by means of levers and cables to the holder bell so that it will remain wide open until the bell rises within a few feet of its upper position, and close gradually till at the highest position it is completely closed. The arrangement shown in Fig. 3 works satisfactorily. The weight *A* must be heavy enough to close the valve and the weight *B* must be heavy enough to open the valve and also lift the weight *A*.

20 All exposed water lines must be protected from freezing. This is especially true of the supply to seals, drips from the gas main, and any line that does not have a continuous flow. With good water separators after the secondary cleaning apparatus, freezing weather or even 8 deg. or 10 deg. fahr. below zero, will not cause trouble in the gas mains themselves, though any valves which may be nearly closed or which are closed part of the time must be carefully protected. The butterfly valve for regulating the gas should be enclosed in a tight box with steam coils to keep it in working order. This also is true of the valves at the gas-washing plant unless it is possible to install them within a heated building.

21 The water in the gas holder must also be warmed. The exhaust from the regulating valve coil will easily keep the holder water warm enough to prevent freezing except in the coldest weather (under 0 deg. fahr.), when it is usually necessary to supply additional steam through several nozzles arranged to set up a circulation of the water around the tank. These should be well down in the water or ice will form on the lower part of the shell and build in toward the center and prevent the lowering of the bell.

22 During the time the holder water is warmed it is important frequently to observe its temperature, if too hot it will charge the gas with water so that condensation and freezing will take place in the gas-engine supply pipes. When the water circulates properly in the holder it is not necessary to have it any warmer than 38 deg. or 40 deg. fahr., while a rise to 65 deg. or 70 deg. will give trouble.

23 If the gas holder is not visible from the gas-washing plant the operator needs a visible signal to give him its position, also an audible signal to inform him if it should lower beyond safe working position, the amount of the drop allowable before the audible signal operates being determined by the position of the regulating valve at the holder. The drop should be less than an amount to give a complete opening of the valve. The gas-washer operator should have telephone connections with the engine room, besides the usual whistle or bell signals which are used to notify him of the starting or stopping of engines. He should also be in close touch with the blast-furnace department in order that any change in the gas supply can be known in advance.

RELIEF DOORS

24 In all gas-pipe lines so-called explosion doors are installed. These are as a rule useful only for access to the main for cleaning, usually being made of cast iron and hinged; on account of their weight and method of attachment the moment of inertia is so great that they will not open quickly enough to prevent the destruction of the main in which they are installed. Any gas main that will support itself over the span usually employed will easily stand any pressure that can be produced in the cleaning plant, and the use of these valves or other relief valves is not necessary. The inconvenience of escaping gas makes it advisable to design them as cleaning doors only, and to arrange them with a clamp fastening to avoid this inconvenience. If it is thought necessary to instal explosion doors or valves I would suggest the use of sheets of light material arranged in frames so that they will be blown out should an explosion occur in the main.

25 The best protection from explosions is careful operation, especially to guard against a reduction of pressure of gas at the furnace side of the cleaning plant due to no air being drawn into the main at the stoves, and to see that no piece of apparatus is put in service with air trapped so it can be mixed with the gas and sent along to the engines.

RECORDING INSTRUMENTS

26 Thermometers and pressure gages for indicating the temperature and pressure of the gas: entering the cleaning plant, between the primary and secondary washers leaving the latter, and before and after the gas holder, form important parts of the gas-cleaning system. The ordinary gas works thermometer with a stem reaching about 8 to 10 in. into the gas mains are to be located at each of the above points, while pressure gages of the U-tube type with inches of water as a measure of the pressure can be located in the gas-washer building and connected to these points by 3/8-in. or 1/2-in. gas pipe. Recording gages should be used in connection with the indicating water column for the gas pressure at the entrance to the cleaning plant and in the gas main leading to the gas holder.

LOG RECORDS

27 The successful operation of the gas-washing plant is very much advanced by the proper understanding of the meaning of the variation shown by these thermometers and gages. For this reason it is important to keep a record of these variations on

carefully designed daily log sheets with at least eight daily notations. The gas-washer operator soon learns to interpret the gage and thermometer changes, and will often foretell serious trouble by such understanding. For instance, the partial filling of a water seal is indicated some time before it will cause trouble by the swinging of the water in the U-tube, this movement being so markedly different from any other that he knows at once the trouble and from the location of the gage can easily tell which seal is filling.

28 The daily log sheets should have space reserved for the operator to note any unusual occurrence and the work done to keep the plant in condition. It should be in fact a complete report of each day's work to the engineer in charge, keeping him in close touch with the changing conditions in the gas-cleaning system.

ENGINE STARTING

29 A second most important factor in successful gas-engine operation is good engine operators, and the same characteristics which are valuable in steam-engine operators are valuable in the gas-engine engineer.

30 The operation of the engines themselves is exactly similar as far as the running gear is concerned and it is only the fact that the gas engineer is fireman as well as engineer that makes it necessary that he be more alert and watchful. Economical operation of gas engines on the same account requires that the engine operator must have his sense of "the feel of the machine" well developed.

31 Compressed air at from 150 to 200 lb. per sq. in. pressure has proved satisfactory for starting gas engines and is especially desirable on account of the ease with which a suitable quantity can be stored under pressure ready for use at any time.

32 In a starting system of 2000 cu. ft. capacity the air pressure is lowered about 20 lb. in starting one 3000-kw. twin-tandem unit, and since 150 lb. pressure is sufficient for a start there is a possibility of at least three starts from 200 lb. initial pressure, which is certainly sufficient to get under way even during the excitement of an emergency shutdown.

33 Record was kept of the pressure drop in starting an 1800-h.p. twin-tandem Allis-Chalmers engine from an air system having two tanks of 1100 cu. ft. capacity each. This record included 19 starts, 16 using the full capacity of the system and three with

one tank out of service. This record is plotted in Fig. 4 the pressure in the system being shown as ordinates and the pressure drop as abscissae; the 16 starts with complete air system in use are indicated by circles and the three that were made with one of the air tanks shut off, by crosses. It may be noted that the quantity of air required to start the engine was about the same, regardless of the pressure in the air tanks.

34 The necessary capacity of air tanks and air compressors for a given plant depends upon the number and size of engine units, and the frequency with which they may need to be started. After the engine operator becomes familiar with the operating

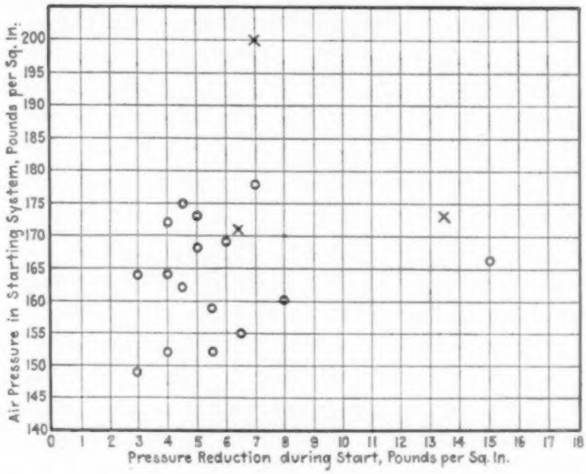

FIG. 4 RECORD OF PRESSURE DROP

peculiarities of the engines he should be able to start them at intervals of from 4 to 8 minutes and not lower the air pressure more than the compressor can make up in that time, if an engine lowers the pressure 8 lb. per sq. in. in a 2000-cu. ft. capacity system, the compressors should compress 8/15 of 2000 = 1060 cu. ft. free air in the maximum time allowable between starts or say 10 minutes. This would require two 106-cu. ft. compressors.

35 For the ordinary blast-furnace gas-engine plant of from three to six engines two air compressors of 100 cu. ft. capacity and air tank capacity of 2000 cu. ft. are quite sufficient, while for more than six engines the compressor capacity should be increased rather than the tank volume. At least one of the compressors must derive its power from some source outside of the

gas engine in order to be able to start the plant if all units should be down.

36 It is important to keep the water jackets thoroughly clean and the item of jacket cleaning should appear regularly in the engine operation schedule. This cleaning requires careful attention since, with the class of labor usually put on this work, it will be slighted in the places where the most care is needed.

LUBRICATION, CLEANING OIL

37 The question of lubrication is one of so many variations I can only say that for general lubrication of such as main bearings, crosshead and crankspins and crosshead slides where the rubbing surfaces are at room temperature, an oil of the following physical characteristics has given excellent service:

Specific gravity	.888
Viscosity (Tagliabue)	.210 at 70 deg. fahr.
Cold test	35 deg. fahr.
Flash temperature	.435

38 This service also includes satisfactory separation of water and dirt by settling and filtration. On account of the almost certain mixing of water from the cooling system with the system oil, it is necessary to provide means of separating the water and oil in the filtration process and it can be done thoroughly only by heating the oil to about 160 deg. or 190 deg. fahr. and giving it time in a quiet condition to allow the separation. A large part of the dirt will settle with the water. Such that does not, must be removed by filtration through fine cloth either of organic fiber or of fine wire. The latter is more to be desired because of the ease with which it can be cleaned.

39 A good oil-cleaning system giving excellent satisfaction consists of one 1500-gal. water-separating tank, shown in Fig. 5, with a heating coil over which the oil flows as it enters on returning from the engines, and an adjustable automatic water overflow to discharge the separated water, two settling tanks of the same size through which the oil passes in tandem to allow time for quiet settling of dirt particles, and a filter unit with 20 filter bags, 10 each in two filter tanks.

40 An extra tank is used when either of the other three is out of service for cleaning. An auxiliary tank of about 200 gal. capacity is used for "boiling up" the sludge taken from either of the large tanks or the filters at time of cleaning as well as such dirty oil as can be drawn off daily from the bottom of the overhead oil tank.

41 This system is shown in Fig. 6. The oil from the engine drips enters tank *A* over the steam coil, flows down through the inner cone then up and out the overflow to *C* and *D*, thence to the filters *F* and *G* through *E*, which is also a water separator. The clean oil is pumped from the filters by one of the pumps at *K*, which are in duplicate, to the overhead engine supply tank in which the quantity of oil on hand is shown by an index on a large gage visible from the engine-room floor. Gage glasses on

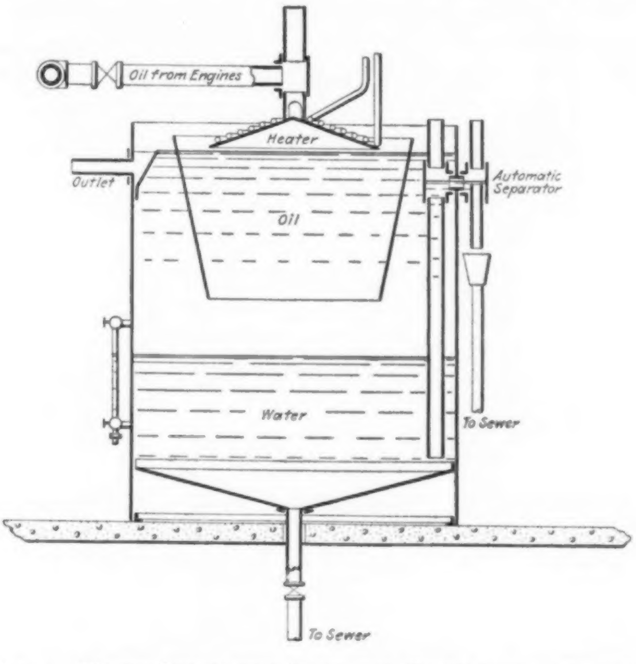

FIG. 5 WATER-SEPARATING TANK FOR OIL-CLEANING SYSTEM

each tank show the level of the line between the oil and water both as an operating convenience and as a means of checking the quantity of oil used during the month. The separated water flows down the inside of the cone in *A* to the bottom of the tank from which it flows through the automatic overflow *H*. The nipple in the tee at *H* is adjustable so that the water in *A* can be held at the level found best in operation.

42 A part of the dirt is oil-coated so that it floats between the water and the oil and will accumulate until its removal is necessary. The oil from the engines is then turned into tank *B*,

the supply to *C* and *D* being kept up by stopping the water overflow and filling *A* with water as long as good oil flows out. The water is then drawn off to the sewer and the sludge pumped into the boiling tank *J* where as much oil is reclaimed as possible. The other tanks are cleaned in the same way. There are pipe

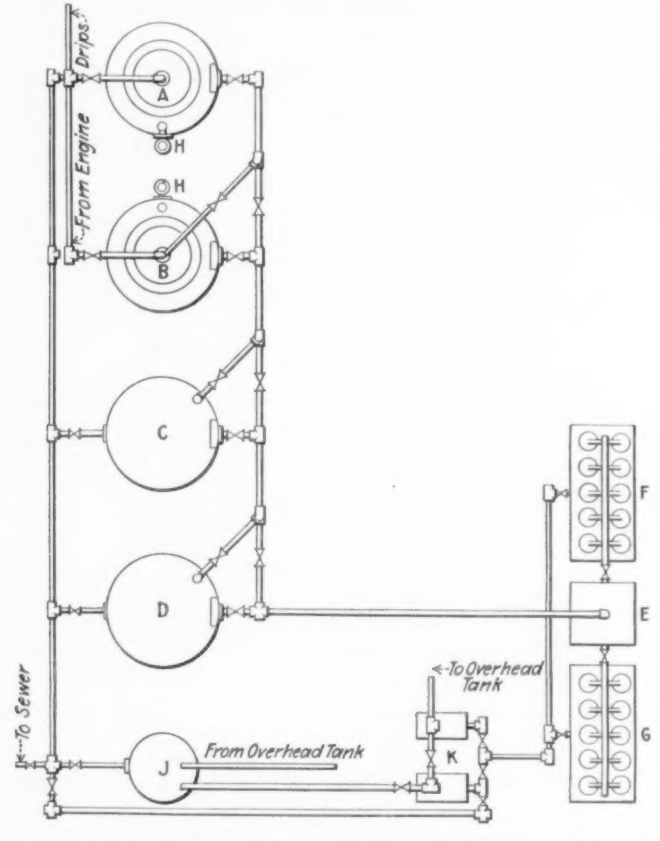

Fig. 6 Oil-Cleaning System: *A* and *B*, Water-Separating Tanks; *F* and *G* Filters; *J* Boiling Tank

connections from the bottom of all tanks to one of the pumps, also from the discharge of this pump to the tank *J*.

43 Such an oil system will keep the oil clean for a plant circulating 500 to 600 gal. per hour. Of course some oil is lost through leakage at the engines, and some is wiped up in keeping the engines clean, but the addition of new oil need not amount to more than 100 gal. per month. In blowing-engine plants where the engine oil is drawn into the blowing cylinders from mechan-

ically operated valves the oil consumption will not be so low unless good oil separators are installed in the cold blast mains arranged to discharge this oil back into the oil system.

44 The cylinder oil question is also one of many opinions. The varying cleanliness of the gas, hardness of cylinder walls and piston rings, piston speeds, mean effective and maximum pressures all have their influence on the action of the cylinder oil. An oil showing a specific gravity of 0.902; viscosity (Tagliabue) of 78 at 212 deg. fahr., and a flash temperature of 380, gave excellent results in a gas blowing-engine plant where the dust was low (0.01 or less) and piston speeds less than 600 ft. per min., and was not satisfactory in another, with 0.012 dust and piston speeds of 850 ft. per min. In the latter case the oil was replaced by one of specific gravity, 0.920; viscosity, 203 at 212 deg. fahr.; and flash temperature, 502, and immediate improvement was shown.

45 With the lighter oil the cylinders were not dry in any part though they did show more wear than was expected for the time in service, the machining marks in the bore being almost invisible after three months' operation.

46 The cylinder oil can be put in a tank in the basement and piped to all cylinder oil pumps by using compressed air at 15 lb. per sq. in. This provides opportunity for the installation of oil meters to keep accurate account of the oil used on each engine, or the supply tank may be equipped with graduated gage glass and record kept of the supply to the whole plant.

IGNITION

47 The mechanically operated igniter is much to be preferred over the magnetic type. The current supply should be from a source not liable to fluctuation, such as that from a motor generator set that supplies current to the ignition system alone and arranged in connection with a storage battery so that should anything happen to the motor generators the battery would take up the load, automatically signaling the operator. The location of the ignition plugs is important, since an explosion on one side only of the piston will force it to the other side and cause it to strike the cylinder wall. This is easily apparent in cylinders having the combustion chamber at the side and the effect of one-sided explosions can be seen when one of three equally spaced igniters is not working.

48 Premature ignition is usually caused by excess hydrogen in the gas, and will occur when the quantity of hydrogen reaches 4.6 per cent, depending also upon the cleanliness of the cylinders. This prematuring is one of the first indications of leaking cooling plates in the furnace and the gas-engine operator will often be able to inform the furnaces of this condition before they learn of it themselves. When a furnace has the wind off for casting, the water pressure in the cooling plates is greater than the furnace pressure and the water enters the furnace and is immediately dissociated, the oxygen being consumed by the coke leaves the excess hydrogen in the gas. When the wind is put on again this gas, rich in hydrogen, is sent along to the engine causing prematuring.

MISCELLANEOUS INFORMATION

49 The pistons of the early large gas engines were of cast iron but these gave considerable trouble by cracking because they were not properly ribbed. Several builders changed to cast steel, but found they gave trouble either by cutting the cylinder walls or by beading over and binding the rings. Cast iron was again resorted to with an improved design. In the cast-steel pistons also the movement of the rings widens the grooves so that in a short time there is too much clearance which necessitates turning the grooves and making new rings.

50 Cast-iron snap rings of uniform cross-section give better service than any other type. This has been learned after many attempts to design a complicated ring, the designer believing a ring to hold gas-engine pressure would be more difficult to make than one for steam-engine pressure.

51 Piston-rod packing furnishes one of the difficult problems for the designer and also for the engine operator. A good packing must be simple in design and, as in the case with the piston rings, the forms with the fewest parts seem to give the best service. Both cast iron and babbitt have given good results. The success or failure of this part of the engine depends largely upon its cleanliness and too much care cannot be used in assembling it to insure its proper application.

52 The engine-room basement has not received the attention it deserves. Two items the designer of any power plant will do well to consider are: make the engine-room floor high enough over the basement floor to allow 6 ft. clear under all suspended

pipes, and have the basement floor slope enough for rapid drainage (at least 12 in. for 100 ft.). A dry basement with plenty of head room is easily kept clean and a clean basement is a great help in keeping the whole room in good condition. Ventilation and lighting are also more easily accomplished in a high basement.

53 The question of safety of the employee in all occupations is at present a live one and is to be considered in the engine room as well as in the rolling mill. Safety demands the elimination of all dangerous conditions by covering gears, guarding flywheels, generators and crossheads, enclosing electrical apparatus and keeping all gas pipes tight and free from leaks. The men must be trained to watch out for their own and their fellow workmen's safety. It is just as important that the lives and limbs of the engine crew be protected as it is that the cost of electricity should be low.

54 Complete records of operation are invaluable as it is only by the study of accurate record of the actual happenings that we can hope to improve. It is not possible to trust to memory for a comparison of the results of different types or arrangements of apparatus.

55 A daily log of the various pressures and temperatures must be kept to learn whether the plant conditions are changing and to know the cause of these changes. Any unusual occurrence or the regular recurrence of repairs noted on the log sheets puts the information regarding the plant where it can be used in predicting and preparing for the future. Not only should this information be kept daily but it should be collected and averaged monthly and yearly for the comparison of month with month and year with year. Much of the engineering information is best shown graphically, for a sheet full of figures does not give a true conception of the actual conditions.

56 The original information is necessarily furnished on the daily log sheets written by the shift engineer and he should be supplied with a copy of the resulting data sheets. He is just as much interested in the power plant as is the chief engineer and this information cannot be placed anywhere to do more good than with the engine operators. The rate of progress in the gas-engine field depends entirely upon the rapidity with which engineers are able to gain understanding of this machinery and the collecting and compiling of these records is of the greatest service for this purpose.

RAILWAY SESSION

STEEL PASSENGER CAR DESIGN

Papers and Discussion presented at a Meeting held in New York, April 8, 1913, conducted by the Sub-Committee on Railroads of the Committee on Meetings, the New York Local Committee Coöperating

PAPERS

INTRODUCTION TO GENERAL DISCUSSION OF STEEL PASSENGER CAR CONSTRUCTION

By H. H. Vaughan, Montreal, Canada

Member of the Society

The advent of the steel passenger car has brought with it many new problems and an opportunity for more diverse opinions than any other change that has taken place in car equipment. The construction of the wooden passenger car developed along fairly uniform lines. The varieties of framing were few and the differences unimportant, while the introduction of steel platforms, wide and narrow vestibules, reinforced end and sill construction and similar improvements occurred gradually, and with practically similar designs on all railroads. The change from wood to steel in freight car construction resulted in the abandonment of designs that had almost become standardized and the introduction of many new types, but in this case the principal problem, other than that of obtaining satisfactory designs, has been the extent to which it was advisable to use composite or all-steel construction.

2 In the case of the passenger car, the types to be employed will probably not be changed by the substitution of steel for wood. The increase in capacity that has taken place in freight equipment cannot be duplicated in passenger cars, and there appears to be no tendency at present toward any increase in length or carrying capacity. The questions that now confront us relate rather to the design and construction of cars of the present type and of the materials that may be advantageously employed in place of the wood which has been used for so long. They are complicated by the necessity of providing for greater safety for the passengers than was secured in the wooden car, with an equal degree of comfort and the difficulty of anticipating the behavior of this new equipment in the case of accident. Certain difficulties such as the best systems for heating, lighting and ventilation, are common to both steel and wood construction, and improvements in these matters pertain to general progress

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rather than the use of steel construction. The following list, while probably incomplete, outlines in a brief way the important variations that must be considered in deciding on the preferable construction of steel passenger equipment:

Framing	Steel underframe	
	All-steel frame	Center girder Side girder
Outside finish	Plated	
	Sheathed	
Roof construction	Clearstory	
	Circular	
Inside finish	Steel	
	Wood	
End construction	Design and strength	
Floor	Design and material	
Insulation	Material	

No doubt questions of equal importance have been omitted, and in many cases those mentioned require careful consideration with regard to degree, as for instance, the strength of the framing or the thickness of the insulation. The list illustrates, however, the diversity of possible solutions of the preferable steel passenger car, and the following personal opinions are presented for the purpose of opening the discussion:

3 The steel underframe does not appear to be a satisfactory or permanent development. There is but little saving either in weight or cost over the all-steel construction, and it is difficult to see how the same strength in case of accident can be obtained. Experience will show whether the wood superstructure can be secured in such a way as to prevent working as the car gets old, but as it cannot be arranged to carry any weight this appears questionable. It can hardly be regarded except as an intermediate step between all-wood and all-steel construction.

4 In all-steel construction the side-girder car presents advantages, but as in freight construction, both types will probably persist. The side-girder construction obtains greater strength in the side framing without superfluous weight, and it is possible that greater framing strength may prove necessary. With equal strength of side framing the side-girder car may be made lighter than the center-girder type, and the weight of steel passenger cars is one of the most serious problems to be faced by any railroad not having a level line. American passenger equipment was already excessively heavy per passenger carried

with wood construction, and the use of steel has increased this weight from 10 per cent to 20 per cent, which is a most serious matter. Apparently side-girder cars as so far constructed have a decided advantage over the center-girder type in their light weight and greater strength in case of accident tending to crush in the side of the car. This will probably lead to the use of this type on roads on which weight is of importance.

5 In spite of the many advantages of the sheathed car in case of construction and maintenance, it appears that the cost and weight of the additional metal will prevent its extensive use. This question is chiefly one of appearance and convenience, and is of minor importance.

6 The circular roof has been extensively introduced on steel passenger cars on account of its lightness and simplicity of construction. It has the objection that deck sash ventilation cannot be employed. The Pullman Company while using the clearstory roof have, however, discontinued the use of deck sash ventilation, so that evidently in their opinion this objection is not important. The deck sash is, however, of value in a standing car, and when properly screened is certainly advisable in hot weather, especially when the road is dusty. The Canadian Pacific Railway have compromised on this question and are using a roof of approximately circular form with deck sash. The strength and simplicity of the circular roof is retained with the ventilating qualities of the clearstory type.

7 The preferable material for inside finish is a matter for future decision. With the ample protection afforded by a steel car against accident, there does not appear to be any objection to wood inside finish on the ground of safety. It is more ornamental than steel and a better insulator. Probably on no question in passenger car design is opinion so divided amongst both railroad and carbuilders. There is today very little difference in cost, and it certainly appears probable that in the future the tendency will be to adopt steel interior finish if not entirely, at any rate to a great extent.

8 The construction of the ends of the cars has received considerable attention, and the strength now usually employed is enormously greater than anything attempted in wood construction. Several excellent designs have been devised, which will probably be referred to in another paper.

9 The floor construction in steel cars is entirely different

from that in wooden cars, and is usually of metal covered with a flexible cement. In constructing a sample car for the Canadian Pacific Railway the writer used in addition an underfloor covered with insulating material, and covered the cement with $\frac{1}{2}$ in. of cork. This car was also exceptionally well insulated at the sides, 2 in. of cork being used next the outside plating. Tests during the past winter have shown that this car is actually warmer than the ordinary wooden car, the same amount of heating surface being used in both types. The floor was tested by taking the temperature of water standing in cans on the floor, there being no practical difference between the results in the wood and steel cars. The question of insulation is an important one, both in hot and cold weather, and while other insulation might no doubt be equally effective, it is interesting to be able to advise that with proper insulation there is no question of the steel car being satisfactory.

PROBLEMS OF STEEL PASSENGER CAR DESIGN

By W. F. Kiesel, Jr., Altoona, Pa.

Member of the Society

Whenever it becomes necessary to adopt a policy representing a complete departure from existing policies involving a new theoretical structure from foundation up, many problems, some entirely new, have to be solved. The increasing cost of lumber, the desire for longer and stronger cars, and other considerations indicated the desirability of making a determined effort to develop a satisfactory steel passenger car. The object of this paper is to review a few of the problems encountered, beginning with:

2 *First: Can We afford It, and What will It cost, compared with Wooden Cars?* Tentative designs were prepared and carefully analyzed by a committee of representatives of carbuilders and railroads. The summary of their report was that at first steel passenger cars would cost approximately 20 per cent more per passenger than wooden cars of the best existing types, but that the steel cars would probably cost much less to maintain. They also reported that on account of the increasing cost of good lumber, and the probable decreasing cost of manufacturing steel cars, not many years would elapse before the cost of steel cars would be no more than, if as much as, wooden cars. Those who have been in close touch with the development of the steel-car industry know that at the present time steel cars cost no more than equivalent wood cars.

3 *Second: Shall the Cars be All Steel, or Steel Frame with Wood Lining?* Differences of opinion still exist on this point. Both types of car have been built, and each has strong advocates.

4 In the all-steel car the steel lining can be securely riveted to the framing and adds somewhat to the strength of the com-

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plete structure, but as steel is a good conductor it carries away the heat of a body coming in contact with it, and, therefore, will always feel cold, even when the temperature in the car is sufficiently high. Satisfactory results have been realized from the use of a double steel lining between seats, forming a hot-air duct, extending from the heater pipes to the window sill, with outlet through small holes in the lining proper, located immediately below the window sill in the lining proper.

5 Wood lining requires considerable wood furring, and adds weight to the car without adding to the strength. As the steel frame of a long passenger car may vary as much as ½ in. between extremes of temperature, it is necessary to make allowance in the construction of the wood lining for this variation in length. As a car with metal lining riveted to the framing has the advantage in strength, weight, and cost, it will gain in favor; in fact, it would be at present universally preferred if all railroad shops had practical experience with steel lining, and the necessary proficiency and machinery for its manufacture.

6 *Third: Insulation.* Three general principles have been used for car insulation:

a Wood lining.

b By placing insulating material on the outside of steel lining.

c By placing insulating material on the outside of the steel lining, and on the inside of the steel sheathing.

7 Experiments have been made also with other methods, such as completely filling the space between sheathing and lining with block magnesia and magnesia cement. The problem that presents itself is: Given a car body with a comparatively smooth exterior surface protected by several coats of paint, double walls, painted on both sides—if of steel, isolated air spaces, rather large in volume, between the walls, an inside cubic volume in which the air must be continually renewed, and a window surface of about one-third of the area of the side walls. When single windows are used the air close to the windows is cold in winter, and warm in summer. Double windows improve the situation materially.

8 Experiments made to determine the difference between a wooden and a steel coach, with doors and windows closed, standing on a siding exposed to the sun in hot, summer weather, showed a difference of one to two degrees in favor of the wooden

coach. One day's readings showed an average of one degree difference in temperature in favor of the steel coach, which had insulation only on the outside of the lining. The results of several years' experience indicate that the lining must be insulated throughout, and, if the spaces between lining and sheathing are properly isolated, little is gained by insulating the sheathing, and more will be gained by the use of double windows. Furthermore, the heat lost in cold weather by conduction through and radiation from the walls, in cars with insulation on the lining alone, is negligible when compared with the heat carried off by adequate ventilation.

9 *Fourth: Protection and Safety of Passengers.* This problem involves providing adequate strength for carrying the load, also to prevent collapse or crushing in wrecks, and efficient brakes.

10 The laws governing load-carrying strength are well known, but this cannot be said of the laws governing wrecks. Each wreck forms a separate study, and we seldom find two that can be placed in the same class. The study of wrecks, which, unfortunately, do occur, shows that the car underframe must be reasonably strong to resist end strains, that the ends of the superstructure must be reinforced with strong vertical members, and that the car must not collapse when rolled down an embankment. The gradual elimination of crossings at grade has materially decreased the danger of strains directed against the sides of the car.

11 Early experience with steel freight cars showed clearly that the men handling cars in yards believed that all cars built of steel could withstand much rougher handling than wooden cars. Although the resultant damage to both kinds of freight cars had its disadvantages, it developed a better knowledge of the relative value of steel and wood in car construction, led the designer to abandon the basis of ultimate strength of the material, and to substitute the basis of elastic limit, and finally to select a ratio of 4 to 1 as the relation of the elastic limit of steel as used in cars to that of good timber.

12 That not all designers of steel passenger cars had the advantage of this knowledge, or profited by this experience, is evidenced by some of the car designs which have been illustrated in the technical papers in the past years and which proved fundamentally defective.

13 Selecting from the last generation of wooden cars one used in heavy trunk line service, with four 5-in. by 9-in. wooden sills bunched together near the center, and so located as to be nearly uniformly affected by the end strains, steel platforms with draft gear securely attached, and the remainder of the car to correspond, the analysis of its end-shock resisting capacity leads to the consideration of the elasticity of the material, the transverse bracing preventing buckling, the concentration of strength near the longitudinal center line of car, and the reinforcement at the platforms.

14 The wooden car, therefore, meets many of the requirements enumerated before. A corresponding steel car should have a center sill area of 45 sq. in. braced against buckling, a strong and efficient draft gear as a substitute for the elasticity of the wood, and a ratio of 0.04 for stress to end force, the calculations to include consideration of lever arm of force below neutral axis of the center sills. For lighter service a steel car with center sill area of 32 sq. in. and a ratio of 0.05 for stress to end force may be considered as a substitute for a wooden car with four 4-in. by 8-in. sills bunched near the center of the car. The use of steel permits a distribution of material to better advantage than is possible with wood. The box girder center construction is continually gaining in popularity, the strong vertical members at car ends, to prevent one car overriding and penetrating the superstructure of another car, are now considered a necessity, and a superstructure, including roof sufficiently strong to bear the car when turned upside down without collapsing, is very desirable.

5 To avoid making this paper too long other interesting problems will be omitted, but the truck problem deserves brief consideration. There are four-wheel and six-wheel trucks. They have $4\frac{1}{4}$-in. by 8-in., 5-in. by 9-in., $5\frac{1}{2}$-in. by 9-in. and $5\frac{1}{2}$-in. by 10-in. journals.

16 The impression that cars with six-wheel trucks necessarily have better riding qualities than those with four-wheel trucks has proved to be incorrect. The substitution of four-wheel trucks for six-wheel trucks saves about 18,000 lb. per car. Increased journal bearing surface obtained by an increase of diameter of journal only is of little or no benefit in preventing hot boxes, because the periphery velocity increases in the ratio of the diameters. The weight per journal should not exceed 1500

lb. per in. length. A long spring base, low-lying center plate, and anchoring the dead levers to the car body instead of to the truck frame promote smooth action and easy riding at all times. The equalizing springs should, therefore, be placed as near to the journal boxes as possible, or directly over the boxes, and the bolster springs should be on or near the center line of truck sides. If the dead levers of the truck brake are anchored to the car body, the truck frames have no tendency to tip up when the brakes are applied, and the jarring effect is entirely eliminated. A special axle with $5\frac{1}{2}$-in. by 11-in. journal for passenger cars would be of material benefit, would permit using four-wheel trucks under all coaches and 60-ft. baggage cars, and longer cars with six-wheel trucks would have sufficient margin for the excessive loads sometimes encountered and the danger of hot boxes would be avoided.

UNDERFRAMES FOR STEEL PASSENGER CARS

BY JOHN McE. AMES,[1] NEW YORK

Non-Member

This paper will be confined to underframes of steel passenger cars for through service, or those at least 70 ft. long, and will not attempt to discuss those of suburban or individual service, whose underframes are not subjected to the same severe service strains.

2 The underframe is called upon to perform several functions. Not only must it sustain the weight of the superstructure and load, but withstand impact, oscillation and pulling strains without distortion. Were it not for these conditions the underframe might be considered as a bridge resting upon the center plates and side bearings as piers. Were we to design to meet only the carrying requirements the problem would not be difficult, but the design must also be commercial, not over heavy and in addition sufficiently strong to resist impact; commercial in that plates and shapes employed are such as may readily be secured from the steel mills, and not so heavy as to bring undue work upon either the hauling locomotive, rails, frogs, bridges, etc.

3 The natural division of such designs is:

a Underframes designed to carry equally on all sills
b Underframes designed to carry on center sills only
c Underframes designed to carry on sides only
c Underframes designed to carry on sides and center sills

4 Each of these types has its partisans and each type is in successful operation today. The first is the type used abroad almost universally and at home for repairs under wooden cars, the bodies of which are too good to destroy but need better un-

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derframing. With most of the foreign cars the body rests upon and is bolted to the underframe from which it may readily be removed. The buffing and draft conditions differ from ours in that the buff is taken through the side sills by the use of separate side buffers, and the draft through the center sills thus permitting a distribution of metal in each sill member that may produce uniform stress.

5 An example of the first type designed for a wooden superstructure, consists of four deep sills of what is known as the "fish-belly" type (Fig. 1). These center sills are composed of 5/16-in. plates, 30 in. deep at the center with 3 in. by 3 in. by 3/8 in.

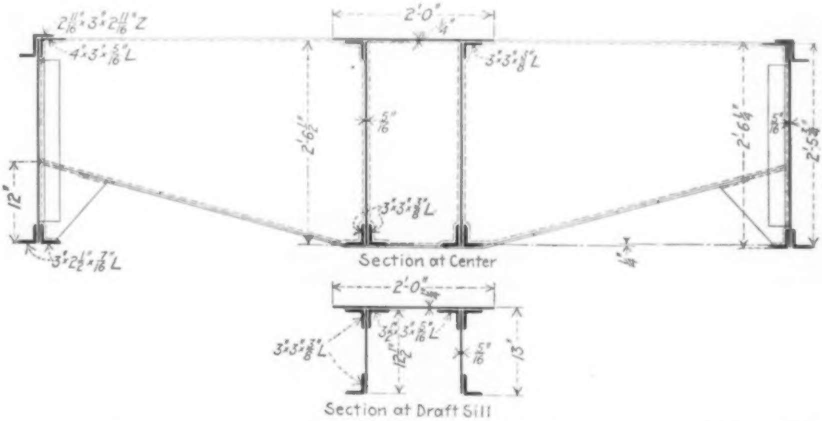

FIG. 1 TYPE *a*: WEIGHT OF CAR CARRIED EQUALLY ON CENTER AND SIDE SILLS

angles riveted along the top and bottom edges; the plates reduced to a depth of 12¾ in. over the bolster. The center sills have a square inch section of 37 at the center, just as the side sills, and 26 at the draw gear. One disadvantage in these long plate sills is that when punching the line of holes along the edges the plate becomes distorted and wavy. It is then difficult to rivet the angles in place and obtain their full value. Again, in case of accident and the dropping of the underframe upon the roadway, the bottom angles are bent or broken, making a difficult repair operation.

6 In general the deep side sill has been discarded because of the difficulty of inspection beneath the car. The deep center sill is much in vogue at present because it looks strong, but on a car with deep center sills inspection must be made of the parts attached to the underframe from one side of the car at a time,

and the introduction of axle light equipment becomes difficult on account of the interference with the deep sills. Again, to sustain its own weight without deflection on a 60 ft. span, too much weight of metal is required to make such a sill economical.

7 Of the second type, that is, with the whole weight to be carried on the center sills, a common form (Fig. 2) has center sills of two special 18-in. channels with ½-in. cover plates top and bottom, all sections extending full length of the car in one piece. The box girder so formed has a square inch section of 50, and the superstructure load is transferred to these sills by means of

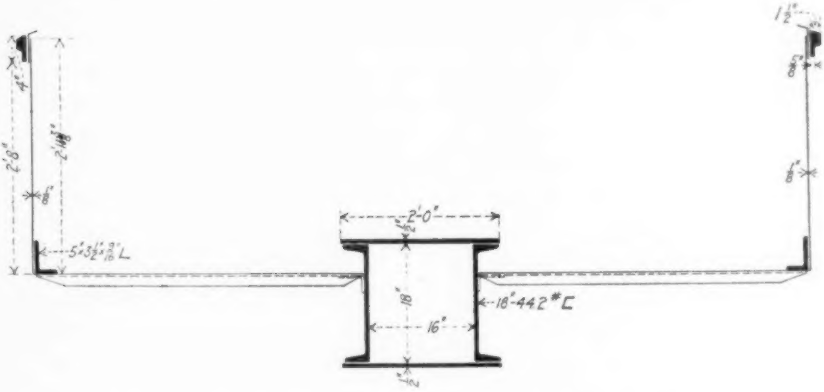

Fig. 2 Type *b*: Whole Weight Carried on Center Sills

four cross bearers, two of which take the place of the body end sills in other designs. There are no side sills as such, the angles here shown simply forming the attachment for the superstructure. The parts are usually assembled with the bottom of the sills upward and allowed to deflect. The girder is then reversed and the camber straightens out by the weight of the metal. The sills are the same depth and section throughout their entire length and with this construction a truck of special design must be used, the center plate of which must be nearer the rail than usual. The weight of the body rests upon the side bearings as well as the center plate. About 20 sq. in. of metal in the sides is available to help sustain the load. The service given by this underframe has been excellent.

8 The third type, with all the weight carried by the car sides has the center sills used only for buffing and pulling. An

example shown in Fig. 3 has two I-beams running full length of the car in one piece, with a square inch sectional area of 23. They are held up by the three cross bearers which pass under and are attached to them. There are no side sills, the carrying members being the sides of the car. These members are composed of 1/8-in. plates, about 36 in. deep, stiffened vertically by the window posts and having a 6 in. by 6 in. by 5/8 in. angle at the bottom and an equal square inch section of metal at the belt rail, the two girders having a square inch section of 48 in all. With this construction a substantial body bolster is essential, as the load must be carried at the bolster extremi-

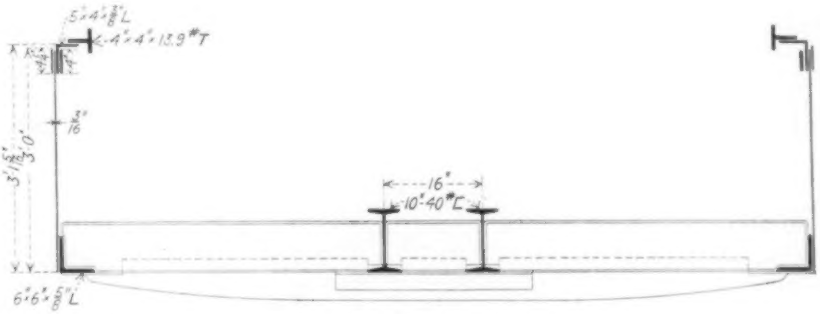

FIG. 3 TYPE *c*: WEIGHT CARRIED BY CAR SIDES, CENTER SILLS USED ONLY FOR BUFFING AND PULLING

ties. Usually a cast-steel structure, built into the underframe and securely riveted to it, is used, the metal may thus be economically distributed. With an underframe of this type there is no trouble due to difficulty of inspection or interference with attachment for axle light or other equipment under the car.

9 The fourth type (Fig. 4) is a combination of types *b* and *c*. Here deep center sills are used, having a square inch section of, say 40 at the center and 39 in cast steel at the draw gear. The side girders have a square inch section of 21 in the two. Most underframes of this type now in service are built with cast-steel end portions which include in one casting the body bolster, platform, side and center sills extending as far back of the bolster as may be necessary to secure a substantial connection to the center sills proper. This center member we do not consider as properly constructed for the reason that the section is unbalanced, an excess of metal being used on the top. Heavier angles or a

cover plate should be used on the bottom, which would add about 10 sq. in. or more of metal.

10 The four types illustrated are of underframes actually in service. A comparison of cross-sections discloses the fact that no matter from what angle the designer has approached the problem, approximately the same square inch cross-section has resulted. If, therefore, any one type has an advantage in weight over the others, it must be attributed to difference in the cross members of the underframe.

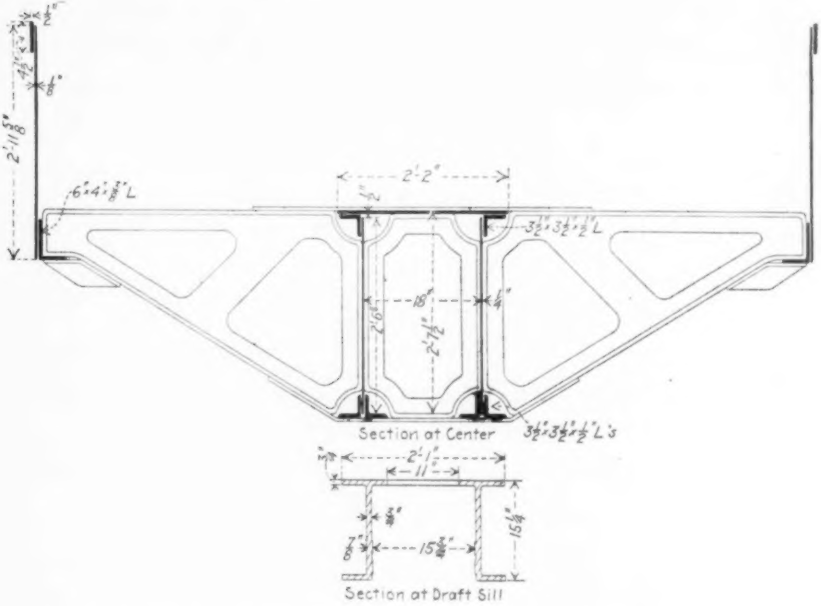

FIG. 4 TYPE *d*: WEIGHT CARRIED BOTH BY CENTER SILLS AND CAR SIDES

11 These four prevalent types have been recognized by the United States Government. The specifications of the Postoffice Department for the construction of steel postal cars provide as follows:

- *a* Heavy center sill construction, the center sills acting as the main carrying member.
- *b* Side-carrying construction, the sides of the car acting as the main carrying members, having their support at the bolsters.

c Underframe construction, in which the load is carried by all the longitudinal members of the lower frame. The superstructure shall be of steel.

d Combination construction in which the side frames carry a part of the load, transfering it to the center sills at points remote from the center plate for the purpose of utilizing uniform center sill area.

12 While several of these types have been in service for a number of years the required time has not passed in which to develop structural defects due to unseen causes, such as fatigue of metal, crystallization, etc. If such defects exist they should make themselves known during the next three or four years, if freight construction is any criterion.

ROOF STRUCTURE FOR STEEL CARS

By C. A. Seley,[1] Chicago, Ill.

Non-Member

Roofs for steel passenger equipment cars are of two classes, the clearstory type with minor variations and the oval type. As regards contour and general appearance, they are the same as the long established standards for wooden cars, but varied as to constructive detail, due to materials employed.

2 The advent of the steel car has rather encouraged the use of the oval or round roof, as it is often called, particularly for cars used for baggage, express, and postal purposes. It is cheaper to build and maintain and fulfills requirements for such cars. For passenger cars the clearstory type prevails very generally, as it assists in lighting and ventilation and in decorative effect.

3 The framing for oval roofs consists of carlines, each a single member, bent to the shape of the arch and extending from plate to plate. There are no through longitudinal members and the roof sheets are riveted to the carlines.

4 Framing of clearstory roofs is of two general classes, one employing carlines of one piece extending from plate to plate and carrying the longitudinal upper deck sills and plates, and the other class an extension of the side framing posts as far as the upper deck sill. To these extensions are attached a member which comprises deck posts and upper deck carlines. It is difficult to approximate the strength of the more direct lines of the oval roof in the design of the clearstory roof, and all riveted connections must be thoroughly considered. The deck sills and plates are through members, act as end stiffeners, and add to the longitudinal strength.

5 The shape of the carlines of either type of roof should be such as to facilitate fastening of roof and of the inner ceiling or finish, and between these there should be a generous amount

[1] Mechanical Engineer, Rock Island Lines.

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of insulating material to intercept the heat of summer and the cold of winter.

6 The committee of engineers who framed the specification for full postal car construction, which was approved by the Post-office Department in March 1912, contains the following paragraphs in regard to the roofs of such cars and is probably as authoritative a statement as there is available. The strength of roofs of some cars that have been rolled over in accidents has been checked against the formula used, and it has been found ample to afford support against serious roof distortion in such cases.

7 The postal specification reads as follows:

ROOF

"General

The roof may be of either the clear-story or turtle-back type, depending on the standard contour of the railroad for whose service the cars are built. In the clear-story type, the deck plates shall be in the form of a continuous plate girder, extending from upper-deck eaves to deck sill, and either built up of pressed or rolled shapes or pressed in one piece from steel plates. The car lines may be either rolled or pressed steel shapes, extending in one length across car from side plate to side plate, or may extend only across upper deck. In the latter case the lower deck carlines may be formed by cantilever extensions of the side posts or by independent members of pressed or rolled shapes. In the turtle-back type, the carlines may be of either pressed or rolled shapes, extending in one length across car between side plate and side plate, or may consist of cantilever extensions of the posts.

"Carlines

The projected area of the portion of roof in square feet, supported by carlines, divided by the sum of the section moduli of the carlines, must not be more than 100.

"Roof Sheets

Roof sheets, if of steel or iron, shall be of a minimum thickness of 0.05 inches, and either riveted or welded at their edges."

8 The design of the roof is also subject to the general paragraphs on stresses and details of the postal car specification.

9 There are several bills in Congress having in view the substitution of steel passenger equipment on railroads for present wooden cars. Should any of these become law, specifications for construction will be necessary, and, as the postal car specification has been approved and adopted as standard by the Government, no doubt this specification will be used as a basis in determining the requirements for other steel passenger equipment cars, not only for the roofs, but for the other features of construction.

SUSPENSION OF STEEL CARS

By E. W. Summers,[1] Pittsburgh, Pa.

Non-Member

If we could operate steel cars over rails having no kinks, curves or irregularities in their alignment, in other words, over an absolutely straight track, there would be little need of springs or other devices for flexible support.

2 Unfortunately the roadways we have to contend with cannot be made or maintained in true alignment. Frost and water make constant changes in the track support. Lateral curvature requires super-elevation of the outer rail. In passing from a tangent to a curve, or vice versa, the tracks under one truck are in wind with those under the other one, sometimes as much as 4 or 5 in. depending upon the degree of curvature and the length of the car.

3 Steel car bodies of the enclosed type, such as box cars, mail, baggage, or passenger coaches, are of rigid construction and have high torsional resistance. A three-legged stool on an irregular floor surface will stand upon all of its legs while one having four legs may carry all of its load upon two diagonal supports.

4 The use of truck springs helps the illusion that we are distributing the car body load on all of the wheels. The uneven deflection of the springs indicates directly the increased load of one spring over the other. When the track surface is warped more than the total spring travel, the whole load is carried at two diagonal corners, tending to twist the car body. This twisting tendency is constantly changing, first in one direction and then in the other, as the super-elevated rail changes from one side of the track to the other. The effect upon wooden passenger cars is to work the joints loose and cause them to screech and grind like the spokes of a wooden wagon wheel in hot dry weather.

[1] President, Summers Steel Car Company

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5 The side bearings of steel sleeping cars pop like sledge hammer blows when the car is taking or leaving a curve. The slight twist in the track surface throwing excessive load upon two diagonal corners of the car causes the bearings to grip and adhere to each other coincident with the slewing of the truck. When the twisting of the truck exceeds the play in the parts around the truck bolster the side bearings let loose and jump with the resulting hammer blows. More efficient roller side bearings may prevent the gripping and jumping, but the uneven load is still present. The twisting effect upon the car body is not removed.

6 Failure in roofs of wooden box cars and the resulting damage to merchandise in transit is due to this constant twist. Roof designers have attempted to remedy this by making the roof flexible and with slip joints. To be consistent they should go further and make the whole car of india rubber. A practical construction for the enclosed type of steel car bodies must and always will be rigid and of high torsional resistance.

7 The necessity for flexibility between the car body and the trucks, and for an even distribution of the load upon all of the wheels seems not to be fully appreciated as yet, but with each succeeding year wrecks due to broken rails, wheels and truck structure will drive this home. Suspension of steel cars, as has been developed by the writer in the past three years, does permit of a more even distribution of the load upon the wheels than with center-bearing trucks.

8 Fig. 1 is an illustration of a cross-section through an engine tender at the center of one of the trucks. It illustrates the method of suspension referred to and is applicable to any kind of car.

9 The inclined hangers *a*, the cradle *b*, and the side rockers *c* are shown heavily shaded. There are two inclined hangers at each side of each truck. A heavy rectangular bar extends through the lower ends of the hangers *a*. A cast-steel bracket, which is part of the car underframe, rests upon each end of the rectangular bar. The upper ends of inclined hangers *a* are supported upon the outer end of the cradle which rests upon the segmental rocker *c* and transmits the car body load directly into the truck side frame. The lower ends of hangers *a* are maintained a fixed distance apart transversely of the car, by reason of the brackets *d* being a fixed part of the car underframe. Their upper ends are held at a fixed transverse distance by their connection with

the cradle *b*. Both the upper and lower ends of bars *a* are pivotally connected with rolling contact.

10 With one end of a car on level track and the other end having one rail at a higher elevation, the tendency will be for

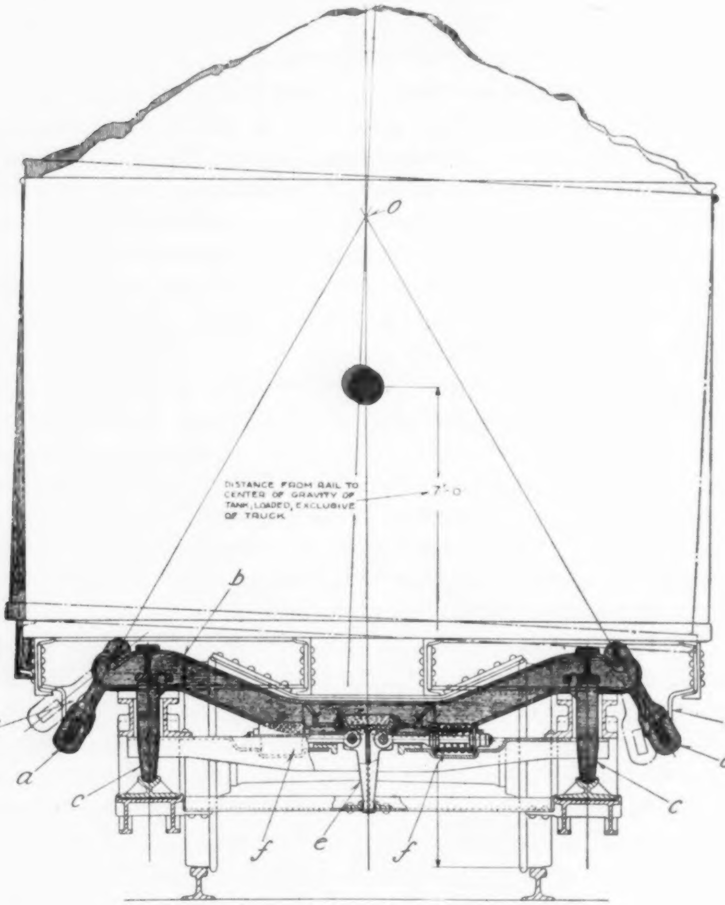

FIG. 1 CROSS-SECTION OF ENGINE TENDER AT CENTER OF ONE OF TRUCKS

the high rail to carry all of the load at that end of the car, or to have the car support taken at two of its diagonal corners.

11 With *inclined hanger suspension* the car will swing sideways, the hangers at the high rail swinging inward and down-

ward, while the ones at the other end of the cradle swing outward and upward, picking up the load at the low rail and maintaining its distribution on all of the wheels much the same as if suspended by two bars from a point *O* at the intersection of the center line of the inclined hangers extended. The load or rigid car body will find its own position vertically under this common point of support *O*, each of the extended suspension bars taking its share of the load.

12 The slight warping of the track surface, which causes all of the load to be carried on half of the wheels at two diagonal corners of a rigid car body with the ordinary center-bearing truck, is corrected by the short inclined suspension bars *a*, practically the same as if the suspension was from point *O*.

13 It is the inclination of these bars that makes vertical adjustment possible, one bar swinging inward and downward, the other swinging outward and upward at one end of the car, the bars at the other end swinging in the opposite direction, the car body finding its position much the same as a boat does in water.

14 Imagine the bars *a* at one end of a car swung to the left, as shown in the unshaded dotted position, and at the other end swung to the right an equal amount: this makes correction for a warped track surface of about 8 in. in the length of a car. Or, imagine the hangers *a* swung to the left at both ends of the car, as shown in the dotted position: this is the inclination the car body will assume in rounding a sharp curve at high velocity, the top of the car leaning inward and the bottom swinging outward, the position assumed by a bicycle rider in rounding a curve.

15 The cradle *b* is pivoted about a vertical axis on the king pin *e* and can also have movement transversely of the car, this movement being limited by the action of springs *f*. On account of the inertia of the car body and its load, the cradle moves transversely of the car, rotating the hangers about their lower ends when rough track is encountered at high speed. Without this cradle movement, the inclined hangers are impracticable; with it, the car body movement is without jar or jerk and we have perfect adjustment for all track conditions.

16 The car body is carried at each side almost directly under its rigid side girders, which by position have great depth and can carry the load with the least deflection. Floor beams may be made continuous from side to side of the car. The necessary buffing and tugging column may be disposed with its web in a

horizontal position under the transverse beams, greatly simplifying the car framing.

17 With the advent of steel construction for enclosed cars a rigid structure came into use, one that cannot be handled over rough track as we have been handling the spongy wooden structure. There may be much hewing and chopping into old methods before the necessary compromise is made between the rigid car body and the changeable track surface, but why not do it all at once, and stop fooling with dynamite?

SIX-WHEEL TRUCKS FOR PASSENGER CARS

By John A. Pilcher, Roanoke, Va.

Member of the Society

Consideration of the subject of trucks for steel passenger cars is practically a consideration of trucks for any passenger car, the primary thought being that steel passenger cars should have steel trucks to prevent the possibility of fire, and also because of their great weight, metal is the most suitable material for strength and durability that can be used in the limited space available for the truck. The fire damage from a wooden frame truck could not be serious on a steel car, and there are wooden cars equally as heavy as the general run of steel cars; the writer having one in mind in the construction of which the sills were plated with 8-in. channels, weighing 172,700 lb. A few steel cars weigh as much as this, but we have no record of any weighing more. However, for steel passenger cars we will consider only the all-steel truck.

2 Practice of the past brings to our attention the pedestal type of passenger truck construction both for four-wheel and six-wheel trucks, the general characteristics of both being identical. The six-wheel truck with the same size axle is, of course, capable of greater load and also of transmitting to the car the track irregularities to a less extent, because the results of the irregularities are modified by the system of equalization. In the six-wheel truck the location of the equalizer springs is fixed at a definite point between the wheels.

3 While the details of these two trucks differ slightly, their functions are practically identical. Both trucks have been used for a considerable length of time, but the four-wheel truck was evidently developed first and its necessary functions, determined by experience, were later incorporated in the design of the six-wheel truck, which was probably first brought about by the increased loads.

4 Except for the especially constructed truck used by the

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Pennsylvania Railroad and one other, which we understand has been designed, these are the only regular types of trucks available.

5 *Wheels.* For passenger service, the wheels have been practically narrowed down to steel tired wheels and wrought-steel wheels. The steel tired wheels have been of many forms of centers and fastenings; the latest recommended practice of the Master Car Builders Association is that the tire be shrunk on and bolted. The recent development of the solid wrought-steel wheel has made available for passenger car service a wheel equally as safe and durable as the steel tired wheel at a very much reduced cost. The Master Car Builders' recommendations recognize both the 36-in. and 38-in. size in this wheel for passenger service, the 36-in., however, being the most generally used. These wheels, if carefully turned, should give as satisfactory service as any wheels available.

6 *Axles.* The standards of the Master Car Builders Association gives the choice of selection of four sizes of axles:

Size of Journal	Axle Load, Lb.
$3\frac{3}{4}$ in. x 7 in	15,000
$4\frac{1}{4}$ " x 8 "	22,000
5 " x 9 "	31,000
$5\frac{1}{2}$ " x 10 "	38,000

7 They also offer an axle as recommended practice with 6 in. by 11 in. journals for 50,000-lb. axle load. These loads, however, are for freight service; for passenger service we would recommend the use of from 60 per cent to 75 per cent of the loads used in freight service, based on the light weight of the car, and limiting the load to about 90 per cent of that in freight service, considering the weight of both car and lading. The lighter rating is, of course, to be taken for cars such as baggage and express, since the increased weight on account of lading would be heavier, while the higher rating could be taken for coaches and similar cars where the increase of the lading would be light. Table 1 gives the sizes of axles, and relative light weights of cars on this basis.

8 The Postoffice Department has limited the maximum load per wheel for postal cars to 15,000 lb. when using $5\frac{1}{2}$ in. by 9 in. journals, and to 18,000 lb. when using 5 in. by 10 in. journals, making a further limitation based upon 18,000 lb. as the maximum brake load for any one cast-iron brake shoe under emergency conditions of brake application. This limitation of wheel

loads, after deducting the weights of the wheels and axles, allows a pressure of 304 lb. per sq. in. projected area on the 5 in. by 9 in. journals, and 300 lb. per sq. in. projected area on the $5\frac{1}{2}$ in. by 10 in. journals, also a pressure of 1522 lb. per lineal in. on the 5 in. by 9 in. journals, and 1665 lb. per lineal in. on the $5\frac{1}{2}$ in. by 10 in. journals, and from the experience that some roads have had these seem to be just as high as should be allowed.

TABLE 1 SIZE OF AXLES AND WEIGHT OF LIGHT CARS

Axles, In.	Four-Wheel Trucks, Lb.	Six-Wheel Trucks, Lb.
$3\frac{3}{4}$ x 7	40,000 to 52,000	60,000 to 78,000
$4\frac{1}{4}$ x 8	52,000 to 72,000	78,000 to 108,000
5 x 9	72,000 to 100,000	108,000 to 150,000
$5\frac{1}{2}$ x 10	100,000 to 120,000	150,000 to 180,000

9 *Boxes and Contained Parts.* The Master Car Builders Association has provided standard passenger boxes for axles with $3\frac{3}{4}$ in. by 7 in., $4\frac{1}{4}$ in. by 8 in., and 5 in. by 9 in. journals. For the $5\frac{1}{2}$ in. by 10 in. journal, which is often in use, they have not yet established recommended practices, but the previous designs are having their influence on the shape of the box for this journal.

10 *Pedestals.* Cast-iron pedestals seem to be usually the accepted material, and the Master Car Builders Association has also provided standards to suit the boxes.

11 *Equalizer Springs.* These are four in number on both the four-wheel and six-wheel trucks, and while necessarily provided with a limited amount of deflection, they relieve the heavy truck frames of shock, and on six-wheel trucks provide the points of support for the proper equalization.

12 *Wheel Pieces or Side Frames with Transoms or Cross Ties.* These constitute the truck frame to hold the other parts in their relative position, and at the same time transfer the load from the bolster hangers to the equalizer springs. Being structures supported at four points, they necessarily have to be supported on springs to prevent excessive stresses due to any variations in the height of these four points. As an illustration, when the truck on a tangent is approaching a curve the rise of the

outer rail is about 1 in. in 50 ft. This will raise one of these four points above the plane passed through the other three, and, while the difference is small in the short length of the truck, the irregularity has to be taken up by the springs, otherwise the truck frame would be similar to a four-legged table with one high leg.

13 When we consider the case of a derailment where one wheel of the truck, whether four-wheel or six-wheel, falls into a deep hole, or drops from a high rail, we find this condition exaggerated to such an extent that the whole load will be supported on two points. Then unless the structure is sufficiently flexible to follow, it will necessarily have to be strong enough to resist this abnormal load.

14 The calculation of the stresses under such uncertain conditions of loading is certainly a very complex problem. It is a pertinent question whether or not the designers should undertake to care for such an abnormal condition.

15 *Bolster Hangers.* The lateral movement of the bolster, one of the very necessary features of a passenger truck, is usually accomplished by the use of swinging hangers. This movement should be limited to from 1½ in. to 1¾ in. each side of the center, and in placing this limit arrangement should be made so that the stop will not be abrupt. This is ordinarily accomplished by the use of short hangers, or when long hangers are used by the addition of lateral motion springs, either of which offers an increasing resistance. Rollers on cylindrical or curved plains can produce the identical movement made by the short hangers.

16 *Bolster.* On the four-wheel truck the bolster is a simple beam, but on the six-wheel truck we have a more complex structure resting on four points of support. This condition brings up the same complex problem referred to in connection with the truck frame supported on four points, except that it rests on much more flexible springs than does the truck frame. These springs can hardly be expected to take up all of the variations in elevation that will likely be met with in case of a partial derailment. The same question as to whether or not the designer should allow for such abnormal conditions is again raised.

17 *Center Plate.* The usually accepted center plate for passenger cars is of the spherical pattern, allowing more perfect adjustment, and more even distribution of weights than can be obtained from the flat bottom center plate, but making necessary

close and accurate adjustment of the side bearings to prevent the rocking movement between the car body bolster and the truck bolster.

18 The frictionless center plate would of course be very desirable, but conical rollers and balls of sufficient number, of the size that can be put in the available space, seem not to have been as successful as could be wished. The ingenious designer is still at work on this particular problem.

19 *Side Bearings.* Side bearings must be made so that they can be readily kept adjusted to reduce to a minimum the rocking movement between the car body bolster and the truck bolster, and in this way confine the oscillation of the car to the variation in the deflection of the springs on either side.

20 The relative location of the side bearings, each side of the center, is a question often discussed. In passenger cars the practise generally is to place them at as great a distance from the center as practical. This in our judgment is correct, and of particular advantage in the case of frictionless or roller side bearings.

21 Where the side bearings are in actual contact and the bolsters are rigid, the oscillation of the car is controlled entirely by the difference in deflection of the springs on either side, so that if the side bearing is set out sufficiently far to prevent the car body upsetting on the truck, it serves its purpose in preventing car oscillation as well there as at any other location.

22 For the same type of side bearing, it offers just as much, but no more, resistance to turning than if located far from the center, because as the lever arm is increased the pressure is reduced in like proportion.

23 When the car on a tangent is approaching a curve, the rise of the track on the outer rail tends to bring a pressure on the side bearing of the leading truck, next the outside of the curve, and on the side bearing of the trailing truck toward the inside of the curve. Where the side bearings are in contact this variation in elevation has to be taken care of by the deflection of the springs which have to deflect the same amount whether the load is exerted on the bolster, at a point near the center, or far away from the center. If the load comes far from the center it takes much less pressure to influence the deflection of the springs. This would be to the decided advantage of the side bearings, particularly in the case of the frictionless side bearing,

in preventing wear and would also, to a more limited extent, be of advantage to the ordinary flat side bearing.

24 *Brakes.* On passenger cars, the pressure on the brake shoes approximates the loads on the wheels. Particularly is this the case of coaches where the lading is only a small proportion of the total weight. In some braking arrangements the brake shoe load is even greater under certain conditions than the wheel load; therefore the lighter the wheel loads the better for the brakes. This is a decided argument in favor of the six-wheel trucks for heavy cars, and an argument against the use of four-wheel trucks under heavy passenger cars, even though the weights can be readily sustained by the use of sufficiently large axles.

25 The application of the brakes to the six-wheel trucks in such a manner as to allow for the adjustment of worn shoes and worn wheels is a very difficult task on account of the limited space available. It is almost impossible to accomplish this task with the use of wheels less than 36 in. in diameter.

26 *Six-Wheel Trucks.* Since steel cars are of recent construction, and recent conditions have generally called for large cars, the weight is almost always great. The six-wheel, all-metal truck has the following advantages which make for its selection over other types:

a It is non-inflammable.

b It provides a strong material to resist the heavy loads, and occupies only a limited space.

c It provides a durable material.

d It reduces the axle loads, and the unit load on the bearings, lessening the liability to hot boxes, reducing the pressure on the brake shoes, lessening the tendency to heat the wheels and shoes, adding to the life of the brake shoes, and reducing the frequency between renewals and adjustments.

e It spreads the heavier loads over a greater area of structures, and brings more points of contact with the rail, reducing the influence of track irregularities on the riding of the car, and in cases of very heavy cars, where the unit pressure between wheel and rail might approximate the elastic limit, reduces the tendency to shell the wheel and roll out the rail, adding to the life of both.

27 It has been estimated that for a passenger car making 50,000 miles per year, the cost for hauling the car is 5 cents per lb. per year. If the six-wheel trucks weigh 14,000 lb. per car more than the four-wheel trucks necessary to carry the same car, it means the hauling of 14,000 lb. additional at a cost of $700 per year, which brings up a question for vital consideration.

28 While the wheels, brasses, and brake shoes, and other such removable parts may individually have a longer life, there are also more of them in service during the period. Careful comparison would have to be made to determine which has the advantage at this point.

29 *Four-Wheel Trucks.* The four-wheel, all-metal truck is also available in connection with steel cars, and has the advantage of reduced first cost, reduced weight, smaller number of parts to maintain, and if the car is sufficiently light for the unit stress between the rail and wheel to be kept down to a point well below the elastic limit of the material, they should be given serious consideration. The only drawback under these conditions is the possibility of its reduced riding qualities. Its decided advantage in reducing the weight of the train should help to make it a favorite because of the corresponding reduction in the cost of transportation.

30 *Cast-Steel vs. Riveted Wrought-Steel Frames.* The introduction of heavy passenger equipment is rapidly doing away with both the four-wheel and six-wheel wooden frame trucks. The reduced cost of maintenance amply justifies this change if our information is correct. Cast-steel one-piece frames, and riveted wrought-steel frames of various cross-sections have been worked out and are now in use; both are reported as giving satisfactory service, but figures showing the exact relative cost of maintenance are not available.

31 The cast-steel one-piece frame has become a great favorite even in the face of the high unit cost of these particular castings. The adaptability of the castings to the various changes of form and section necessary on account of the limited available space has no doubt had much influence. The attractiveness of the one-piece structure, eliminating all joints, and furnishing a frame ready set up, is another strong argument in its favor. The manufacturers having control of this cast-steel truck frame have evidently been successful in reducing to a minimum the concealed flaws often met with in steel castings. This, no doubt, has added largely to its popularity.

32 While the absence of riveted joints and the consequent doubling of material at the joints, helps to keep down the weight, the fact that the working fiber stress of cast steel is taken low, and the sections at many points have to be made larger than is necessary on account of foundry limitation, the weight of the frame as a whole is great. This added to the large unit cost for special steel castings makes the user pay well for the advantages gained.

33 The riveted wrought-steel frame seems to have been held back in its development by the success of its rival in cast steel. Many users have shown conservatism in making use of the good thing already considered acceptable, hesitating to try out the different construction with the hope of lower first cost, with less weight, and equally good service.

34 Wrought steel at a very moderate unit cost has the advantage of being a very reliable material which can be worked to a relatively high fiber stress. The cost of fabrication, when the work is done in any large quantity, when added to the cost of material, will still leave a large margin in its favor. Is it possible that the lack of an especially interested advocate has prevented its virtues from becoming prominent, and delayed the experience needed to prove, in actual service, its worth?

35 We find that practically all of the prominent car builders have already worked up designs for wrought-steel trucks, and are ready to construct them if the purchaser so desires, but they do not seem inclined to push them, as they evidently offer no special inducement to their own advantage. Only a few have been built and placed under cars by them, and in some cases none, but from what I have been able to find out they have confidence in them.

36 I find several railroad companies building and using both four and six-wheel trucks, of the usual type of construction, with riveted wrought-steel frames, and from all reports they are giving satisfaction.

37 Another prominent railroad is using both four and six-wheel trucks, of a form of construction differing from the ordinary type, built of riveted wrought steel. As a large number of these are in daily evidence, and are constantly being built by them, they must be proving the worth of the riveted wrought-steel construction, as well as that of the special type of construction.

38 Experience of several years and careful comparison of the cost of maintenance will be needed to say whether the one-piece cast-steel frame, or the riveted wrought-steel frame truck will be the most advantageous, when both the first cost and weight are considered along with the cost of maintenance.

39 Variety of choice offers an opportunity for discussion. In the hope of bringing out this discussion we advocate for steel passenger cars:

- *a* Six-wheel truck.
- *b* The riveted wrought steel frame.
- *c* The use of the Master Car Builders standard axles, boxes and parts, and pedestals.
- *d* 36-in. wrought-steel wheels.

STEEL INTERIOR FINISH FOR STEEL PASSENGER CARS

By Felix Koch,[1] McKees Rocks, Pa.

Non-Member

Every one who has followed the progress in steel passenger car construction during the last ten years, which is about the age of the oldest steel passenger car, has noticed that very little, if any steel was used in the interior finish until within the last four or five years.

2 The first attempt to use steel in passenger cars resulted in steel underframes with wood superstructure. The next development provided steel underframe and steel superstructure, but with wooden roof and wood interior finish. Further developments eliminated the wooden roof and the final efforts produced an all steel car. Considering that this development was made during a period of four years, the results obtained are, to say the least, highly gratifying.

3 The earlier designs of steel cars with steel interior finish are sometimes called all steel cars, leaving the impression that they are fire-proof in every respect, but this is not correct because too much wood was used in the form of wood furrings to enable the application of the steel finish with wood screws. These furrings were, of course, not exposed to view, but they nevertheless placed the cars outside of the classification "all steel cars." The idea that it was necessary to use wood furrings in order to make it possible to apply steel finish, or in other words, that wood screws had to be used, machine screws not being considered practicable, accounts to some extent for the tardiness in the introduction of steel in the interior finish.

4 The earlier specifications and designs for steel passenger cars made the use of machine screws for applying the interior finish prohibitive and impossible, which, of course, made it nec-

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essary to employ other means such as bolts or wood screws. Bolts for this purpose must have heads of special design to allow their insertion through slotted holes, etc., and to prevent them from falling through during the application of the nuts. The nuts, being exposed, are objectionable as they give an unsightly appearance, even if special cap nuts are used in place of the ordinary nuts, besides there are many places on a car at which it is impracticable to apply bolts. Therefore, to avoid machine screws and bolts the space between the outside sheets and the interior finish were filled with wood furring to allow for the use of wood screws. The objections to machine screws, caused by the belief that they would work loose in a short time, has, however, disappeared from experience gained through actual service as it has been shown that if set in white lead and properly applied they are entirely reliable.

5 There has always been and there still is a great difference of opinion as to how far it is advisable to substitute metal for wood in passenger car construction. The use of a small amount of wood in the interior finish, as for instance window sash moldings, seat arm rests, window capping, etc., should not be objectionable as it has certain advantages over steel which are desirable, but wood is used for such details to a considerable extent, and hundreds of cars are now in service in which the small amount of wood used in the interior finish cannot be detected except by an expert and such cars are to all intents and purposes fireproof cars, but the aim of many designers has been to eliminate the wood wherever possible on account of the many advantages possessed by steel, among which may be mentioned:

a Steel finish means non-combustion in case of fire.

b Steel prevents splintering in case of wreck.

c Steel finish can be easily removed should it become necessary to repaint the car at the inside surface of steel sheets, as the life of the steel car, to a certain extent, depends on the condition of the paint.

d Steel finish makes it possible to increase the interior width of the car where outside width is limited. This has been found particularly valuable in designing subway, elevated or suburban steel passenger equipment cars.

e Steel finish will avoid trouble which may be experi-

enced due to different expansion of materials, steel against wood. This point need not be considered with steel and makes it unnecessary to provide for relief in all members of the finish running longitudinally, such as upper and lower deck sill moldings, etc. In fact, the steel finish has revolutionized to some degree the designs of wood finish in the wooden cars built since steel cars came in vogue. The cars of today are built on more sanitary lines, and fancy moldings, fretwork and carvings have disappeared without losing sight of giving the cars an artistic finish, avoiding thereby lodging and breeding places for all kinds of germs which the world is fighting against today.

f Steel finish will, by comparison, be cheaper every year for the reason that it becomes more difficult to obtain the right kind of lumber for interior finish, which, of course, means increase in price of wooden cars.

g It is continuously becoming more difficult to obtain men who have had sufficient experience in applying wood interior finish, whereas it does not take the same experienced men for applying steel finish. A man requires from three to four years' apprenticeship to become an expert able to apply wood finish to a car, whereas an average intelligent man who is familiar with tools is able to become an expert in finishing cars with steel finish in from six to twelve months, and this fact of labor will have to be taken into account sooner or later.

h A more uniform color can be maintained on steel finish than on wood which comes in different shades, and it is very difficult and expensive to match perfectly all parts in one car with regard to shade without additional expense of glazing. Furthermore, the average life of paint applied to steel finish will be much greater than to wood finish for the reason that wood darkens with age. This, of course, influences the paint which is a disadvantage from the standpoint of illumination. Should it become necessary to repaint a car of wood finish, reworking of the finish by removal of the varnish and scraping is neces-

sary, whereas in the steel finish the scraping is eliminated and the removing of varnish is alone required to be able to repaint the car.

i Steel finish is of advantage from a building standpoint in the handling and working up of material to make ready for application. Steel details can be worked up to a large extent before they are applied to the cars, which make it possible to manufacture the interior finish in much less time by the use of more men, than it is possible to employ when applying a wood finish, as only a limited number of men have room to work at the same time in a car when the greater part of the fitting and cutting, etc., has to be done. This has facilitated the establishment of a number of manufacturing concerns who devote their efforts almost exclusively to producing steel interior finishes not only for passenger cars but also for buildings. In addition to these any manufacturing company equipped with the necessary machinery for the making of drawn moldings, breaker presses, and ordinary welding and spot welding machines, is able to handle this class of work for railroads or carbuilders, who may not have the necessary equipment to do the work in their own shops and prefer to buy the interior finish as they buy other specialities.

6 All of these advantages are almost exclusively confined to the use of steel or other metals, although a composite material of a wood pulp nature or similar material made fireproof and waterproof by different processes, if applied in a proper way and used for ceilings and below the window sills, is not objectionable, and it may be applied in practically the same manner as steel.

7 The advantages possessed by wood over metal as a nonconductor can be very much reduced by the use of proper insulating material correctly applied. The use of proper insulation is of course of great importance and manufacturers of that class of material as well as railroads and car builders are giving a great deal of attention to the subject, and the time does not seem to be far distant when steel cars with interior finish of wood will be as scarce as steel passenger cars were ten years ago.

8 A great deal more could be said on this subject, but it is hoped that what has been brought out will show that steel interior finish has certain advantages not possessed by other material commonly used in passenger cars and that the disadvantages are few and not insurmountable.

PAINTING OF STEEL PASSENGER CARS

By C. D. Young, Altoona, Pa.

Member of the Society

A fundamental reason for painting any surface of a passenger car is to protect it from the damaging effects of the air which is more or less loaded with gases and moisture. For example, oxygen is destructive of iron and steel and when sulphurous gases are present they are quickly oxidized into sulphuric acid which is very corrosive to unprotected metallic surfaces. It, therefore, becomes necessary to protect the surface by a covering, and paint forms a substantial and convenient means for accomplishing this. If properly made and applied, it is an impervious coating, affording the needed protection by forming a hard waterproof, rubber-like sheeting or film which has sufficient elasticity to conform itself to the contraction and expansion of the surfaces to which it is applied. In addition to protection the surfaces may be beautified and embellished by the proper selection of pigments so as to bring about the harmonizing and artistic effects desired.

WOODEN EQUIPMENT

2 The painting of wooden passenger-car equipment has been, in the main, successfully accomplished, the painting schedule for the outside is briefly as follows: Apply two coats of primer, putty and glaze, followed by three or four coats of surfacers, as found necessary, after which the surfaces are rubbed down smooth with emery and oil, when two coats of shade color are put on. The necessary striping and lettering follows, completing by three coats of finishing varnish, consuming in all about sixteen to eighteen days.

3 The finishing of the interior of wooden cars generally has been in the natural wood, consequently it is only necessary to prepare the surface for the varnishing. A representative sched-

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ule which is used is as follows: One coat of filler, in paste form, which is sandpapered down to a smooth finish. Add one coat of rubbing varnish and rub down with sandpaper, after which apply three coats of rubbing varnish, and complete the finish, cutting down the gloss by rubbing with pumice and oil to produce the most pleasing "flat finish."

4 This method of finishing the wooden surfaces of cars has been attained with good results, so that naturally when the change to steel passenger equipment came some six years ago, a desire to retain as much past practice as possible seemed desirable. It was realized, however, that the all important point in the painting of iron or steel surfaces was first to have the surfaces thoroughly cleaned and entirely rid of scale and rust, as this is as important as the painting itself. To accomplish this, sand-blasting, where possible, was resorted to, supplemented by the use of wire brushes and emery cloth in the more obscure places and the more uneven surfaces. The sand-blasting, however, was confined largely to the outside surfaces and the latter practices to the inside portion of the car.

5 Iron and steel, while not presenting to the eye the same porous condition as wood, is full of finely divided pores, and the same atmospheric influences which enter the pores of wood and cause it to decay are ever ready to attack the unpainted surfaces of iron and steel, in fact the metal surfaces more readily combine with the oxygen and moisture of the air, forming what is rust or oxide of iron. Therefore, immediately after the sand-blasting and cleaning of the surfaces should come the application of the first or primary coat, as this is the most important one, from the preservative standpoint.

6 In the selection of a suitable primer it seemed but natural for the painter to be guided by the experience gained in the painting of locomotive tenders, and to follow the initial coats with practically the same process as with wooden cars, and I believe that so far as the subsequent coats are concerned, this practice was generally carried out by the earlier painting of steel passenger equipment. It is thought that an error has been made in this general practice, as will be explained later.

STEEL EQUIPMENT

7 The schedule for painting steel passenger car trucks, underframes and superstructures is as follows:

8 *Trucks.* Before assembling, all surfaces on truck parts throughout, including all concealed surfaces, but not including wheels and axles, must be covered with one coat of suitable primer. After assembling, all surfaces (except wheels) exposed to view after the body of the car has been placed on trucks, must be covered with two coats of truck enamel.

9 *Underframes.* During the process of construction, all parts of the underframe, including concealed surfaces and surfaces where metal bears on metal, must be covered with two coats of good metal preservative of a non-inflammable nature. All accessible surfaces must be covered with a third coat of metal preservative.

10 *Superstructures.* Before assembling, all parts made of iron or steel, including the roof, must be covered with one coat of primer. A second coat of primer properly thinned with turpentine, or similar material, must be applied to all surfaces, including those which are concealed when the car is completed. Wherever possible, this second coat must be put on after the sheets are in place.

11 After assembling, the outside of side and end sheeting, including letter plate and deck plate, must be covered with one coat of surfacer, the rough and uneven places glazed with "surfacer composition," four coats of surfacer being added, rubbed down with linseed oil and emery cloth, two coats of desired color material added, followed by striping and lettering, then finished with three coats of finishing varnish. The outside of the roof must be finished with one coat of heavy protective paint, followed by one coat of a mixture composed by volume of three parts of mixed ground color and one part of the protective coating used. The top surface and edges of headlining should be painted with two coats of some preservative, or color paint.

12 The interior of cars should receive very careful attention in order to produce the desired finish. To illustrate fully the various steps and time taken to complete the painting, the following is given as outlining the progress of the work. This is attained with the use of surfacers, colors and varnishes containing a relatively large amount of artificial driers and varnish gums, in order to obtain the artistic finish desired for the interior.

HEADLINING

1st day	Apply one coat and stipple after application.
2d day	Stand for drying.

3d day	Apply one coat and stipple after application.
4th day	Stand for drying.
5th day	Apply one coat and stipple after application.

SIDES ABOVE WINDOW SILLS AND ENDS

1st day	Apply one coat or priming.
2d day	Stand for drying.
3d day	Apply one coat surfacer.
4th day	Necessary puttying and glazing.
5th day	Apply as many coats surfacer as are necessary to make a level surface.
6th day	Same as 5th day.
7th day	Rub down with emery and linseed oil.
8th day	Apply one coat of ground color.
9th day	Apply one coat of ground color.
10th day	Apply one coat of ground color.
11th day	Apply one coat and stipple after application.
12th day	Apply one coat rubbing varnish.
13th day	Stand for drying.
14th day	Apply one coat rubbing varnish.
15th day	Stand for drying.
16th day	Apply one coat rubbing varnish.
17th day	Stand for drying.
18th day	Rub with oil and pulverized pumice stone.

SIDES BELOW WINDOWS

1st day	Apply one coat or priming.
2d day	Stand for drying.
3d day	Apply one coat surfacer.
4th day	Necessary puttying and glazing.
5th day	Same as 6th day.
6th day	Apply as many coats surfacer as are necessary to make a level surface.
7th day	Rub down with emery and linseed oil.
8th day	Stand, awaiting bringing up other work.
9th day	Stand, awaiting bringing up other work.
10th day	Apply one coat bronze green.
11th day	Apply one coat bronze green.
12th day	Apply one coat of rubbing varnish.
13th day	Stand for drying.
14th day	Apply one coat of rubbing varnish.
15th day	Stand for drying.
16th day	Apply one coat of rubbing varnish.
17th day	Stand for drying.
18th day	Rub with oil and pulverized pumice stone.

13 Formulae and panels for the various shades should be furnished the painters for their guidance in obtaining the shade of any of the colors which are desired.

RESULTS OF AIR DRYING PAINTS ON STEEL

14 The artificial driers and gums used in hastening the time of drying and hardening of the various coats and permitting the necessary rubbing continue this action so that the paints and varnish increase in hardness and brittleness, rendering them susceptible to cracking and chipping, and the process of disintegration is aggravated by excessive expansion and contraction of the steel surfaces as compared with wood. The linear expansion of steel being more than twice that of wood would seem to indicate the use of more elastic coatings than formerly used for wooden cars.

15 This fact has been borne out in the service of the paint in a great many cases in an investigation which recently came under my observation. It was noticed that when some of the equipment had been in service about four months, the interiors of the cars were showing varnish cracks and checks. As time went on more cars gave evidence of this deterioration, the final outcome being that an investigation was made to see how serious the condition was. Some 400 cars were carefully examined, special attention being paid to choose cars built by various manufacturers, where different makes of surfacers and varnishes were employed. An endeavor was also made to determine whether the cracking of the painted surfaces was confined to the varnish coats or the surfacer coats, or both.

16 In order to classify the various conditions found, four readings of percentages were arbitrarily taken, the condition of a new car being taken at 100 per cent:

Per cent	Condition of Varnish and Surface
90 to 80	Good, no checking
80 to 70	Fair, slight checking
70 to 60	Medium, considerable checking
60 to 50	Poor, checked from outside varnish coat to metal

Sample cars were selected to illustrate these various classes, and photographs were taken of the different defective surfaces so as clearly to indicate to the eye what the different percentages meant.

17 The result of this examination showed that the exteriors, including the sides, ends and vestibules, were in fair condition. There were a few exceptions to this, but they amounted to less than 6 per cent of the total having serious varnish and surface cracks. Interiors were found generally to be in a poor condi-

tion. About 80 per cent of the equipment examined had the varnish checked through to the surfacer.

18 Some of these conditions developed after four to eight months' service, indicating either that an entirely new system of painting would be necessary to overcome these troubles, or that a more elastic paint would have to be used for interior finishing under the present existing practice of painting steel.

19 To obtain some data indicating what should be done to meet the conditions, preliminary experiments were made by painting a number of panels and baking them in a heated oven. Repeated experiments along this line indicated that artificial driers could almost, if not entirely, be eliminated in the paint formulae and that more elastic materials could be used without the aid of artificial oxidizing agents. It was also observed that the elastic varnish used on the exterior of the cars could, under this system, be used to advantage on the interior, and by the aid of the heat of the oven they could be dried to the desired hardness, permitting the rubbing with oil and pumice to get the "flat finish."

20 The outcome of the experiments indicated that it would be desirable to extend the experimental panels to a full size car and, therefore, a proper baking oven was planned that would accommodate one of the largest existing steel passenger cars for the purpose of baking each coat as applied to the exterior and interior surfaces.

21 This oven, as designed and built by the Pennsylvania Railroad Company at its Altoona Shops, is 90 ft. 3 in. long, 13 ft. wide and 15 ft. high. The frame work of this structure is made up of 3-in. I-beams for the sides, spaced 5 ft. centers. The roof framing is made of the same sections and curved to conform closely to the contour of the car roof. Each end of the oven has two large doors which can be readily opened and closed for the baking operation. The oven is lined on the inside with $\frac{1}{8}$-in. steel plate, and on the outside with galvanized iron of 0.022 gage. The 3-in. space is filled with magnesia lagging, thus effecting the needed insulation. The doors are insulated in a similar manner. Along the walls of the interior of the oven are placed 16 rows of $1\frac{1}{2}$-in. steam pipes, and along the floor, close to the walls, are arranged manifold castings with small lengths of pipe tapped into them at right angles. By this means over 2000 sq. ft. of heating surface is provided. A steam pressure of approximately

100 lb. to the square inch is used, thus making it possible to get an oven temperature of over 250 deg. fahr. Rectangular openings, made adjustable, are provided on the sides near the floor line, allowing the necessary admission of air for circulation. Four 8-in. Globe ventilators are spaced at equal distances in the roof, likewise provided with dampers to regulate the size of the opening. By this means of ventilation, fresh air, which is required for the proper drying of paint, is obtained, as well as providing for the egress of the volatile matter present. Automatic ventilation and steam regulation have not, at the present

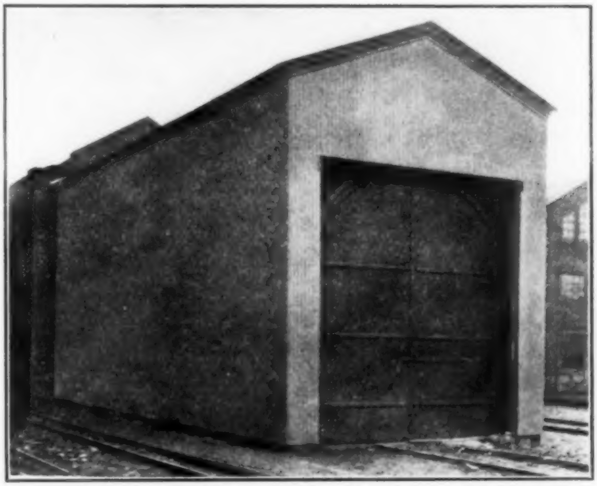

Fig. 1 Exterior Appearance of Oven

time, been applied, but these have been considered advisable, if the result of the experiment seems to warrant a more extended application of the practice.

22 A track is placed on the floor of the oven and connected at each end of the oven with other tracks leading into the regular paint shop where the different coats of paint are applied to the car before each baking operation.

23 Photographs of the general appearance of this oven from the outside, and one end of the interior with a car within the oven are shown in Figs. 1 and 2. Fig. 3 shows the steam piping in detail.

BAKING PAINT ON STEEL

24 The outline of painting a car in this oven is briefly as follows: First, a priming coat is given the exterior and interior of car, which is then moved into the oven and baked for three hours. The temperature at the start is about 160 deg., but rapidly rises

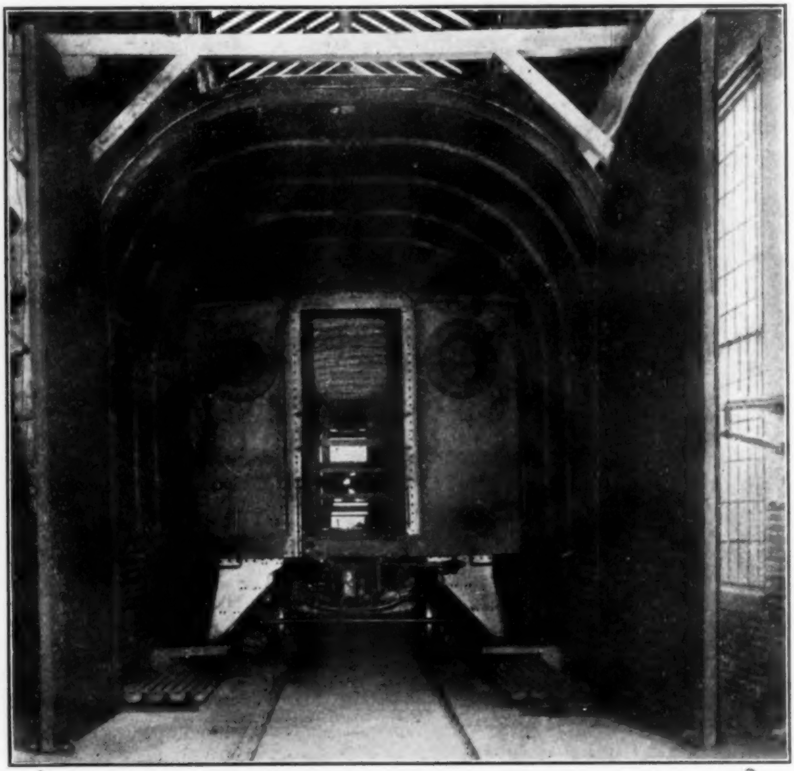

FIG. 2 VIEW OF INTERIOR OF OVEN SHOWING CAR IN PLACE

at about 1 deg. per min. until a temperature of 250 deg. is reached, requiring about 1½ to 2 hours. The oven is held at this temperature until the lapse of 3 hours, when the car is withdrawn, allowed to cool sufficiently to work upon, after which the surfaces are glazed and depressions and uneven places puttied. The car then receives its first coat of surfacer, is returned to the oven for 3 hours, baked and removed for additional coats which

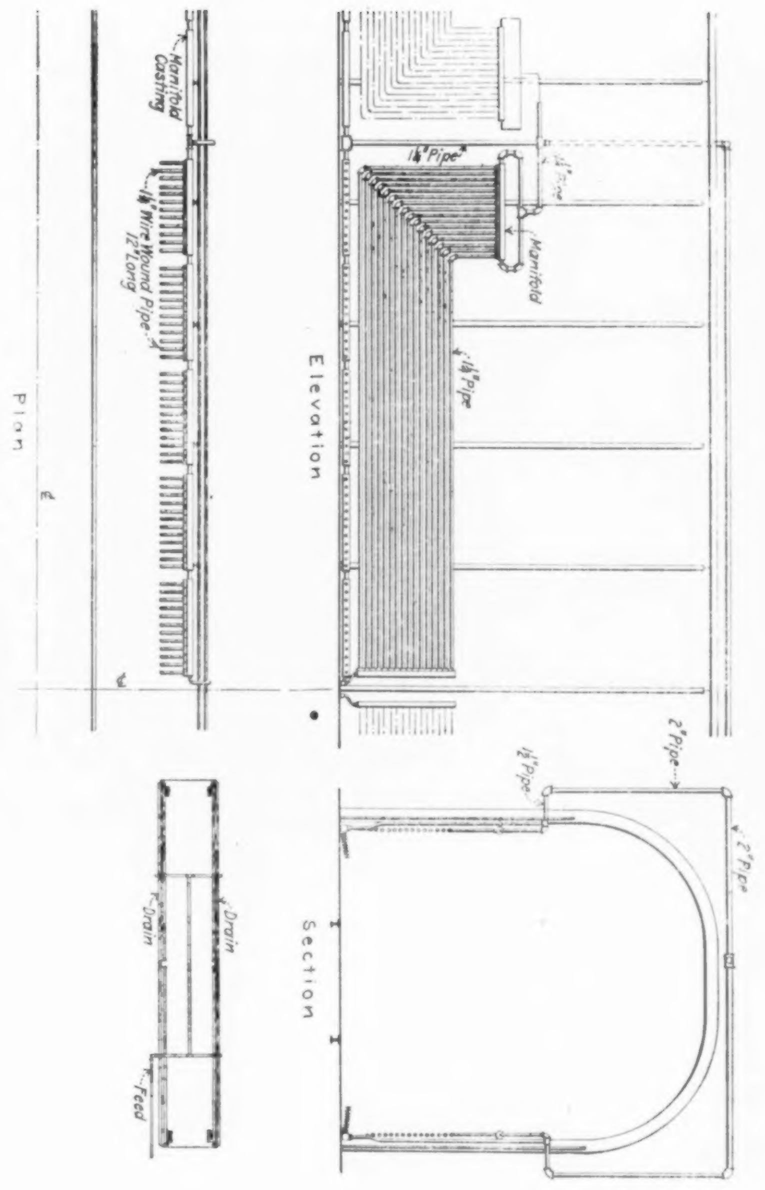

FIG. 3 DETAIL OF STEAM PIPING

vary from two to three in number as the needs of the case require.

25 After the last coat of surfacer has been applied and baked, the outside surface of the body of the car is rubbed down with emery and oil to produce a flat and smooth surface. The various color coats used, such as tuscan red on the outside, pale green, bronze, and bronze green on the inside, are then put on. Two coats of each color are required to get standard shades. Each coat of color is likewise baked.

TABLE 1 TIME SCHEDULE FOR PAINTING EXTERIOR AND INTERIOR OF STEEL PASSENGER CARS

	Outside			Inside		
Period of Work	Body	Roof	Trucks	Body Above Window Sills	Headlining	Body Below Window Sills
1	1st prime	1st prime	....	1st prime	1st prime	1st prime
2	glaze	....	....	glaze	glaze	glaze
3	1st surface	....	....	rub-ground	rub	rub
4	2d surface	2d prime	....	......	......	......
5	3d surface	....	....	......	......	......
6	rub	....	....	......	......	......
7	1st tuscan	3d prime	....	2d ground	1st green	1st green
8	2d tuscan	....	....	stipple	......	......
9	stripe and letter	....	....	......	......	......
10	1st varnish	....	truck	1st varnish	......	2d green
11	2d varnish	....	color	2d varnish	......	......
12	3d varnish	....	....	3d varnish	......	1st varnish
13	......	....	....	rub	2d green air dry	......

26 The car then receives the required lettering, striping, etc., after which the outside and inside surfaces get three coats of a high grade finishing varnish, especially adapted for the baking process. Each coat of varnish is baked at a temperature from 120 deg. fahr. at the start to 150 deg. fahr., which is maintained until the expiration of 3 hours. The interior surfaces of the car are then rubbed with pumice and oil, giving the "flat finish" effect desired, thus completing the painting of the car.

27 To illustrate better the schedule of operation followed, or the timing of the various coats, both for the outside and inside, to secure the most economical conditions, Table 1 is given.

28 All of the work done by the baking process of painting

can be accomplished in six to eight days, thus effecting a saving in time of about ten days as compared with the standard or present air drying system. Further, the paints and varnishes have been worked up so that they are especially adapted for this baking process, having greater elasticity. Exact formulae for the various mixtures are well defined, so that uniformity in material is expected, thus giving greater durability, better appearance and longer life for the paint work.

29 The checks and cracking previously found will be considerably lessened, if not almost removed. By oven painting the work is done under more uniform conditions, which at the present time are so hard to control. It enables the surfaces of the car to be heated uniformly and dried thoroughly, thus removing any objectionable moisture before the first priming coat is applied, which is a very desirable feature of the new method.

30 A considerable saving will be effected by the shorter time that cars will be held out of service when undergoing repairs and repainting in the shops. It is expected that dirt, soot, etc., will not adhere or imbed themselves so readily and that the general appearance of the car will be improved by the baking method.

31 This oven was placed in service the early part of this year and the results of the complete car at this time seem to justify the experiment. They seem to indicate that the results obtained from a small panel can be duplicated in the full size passenger equipment car and that, if this is the case, this method of painting can be used to advantage not only for the painting of steel passenger equipment cars, but for the painting of any other full size steel structure of a similar character where protection and finish are desired.

32 Results and indications at this time seem to justify our expectations that the new process of baking will give, over the present air drying system:

a Longer life of material applied.

b A general appearance as good or better.

c Less cost of material at no increase in the labor charge.

d Complete sanitation for old cars.

e A considerable saving of time for shopping cars, which results in a saving of shop space.

These advantages are offset by the initial cost of installation and operating cost of the oven.

PROVISIONS FOR ELECTRIC LIGHTING IN STEEL PASSENGER CARS

By H. A. Currie,[1] New York

Non-Member

Hardly more than perfunctory attention is, as a rule, given to the lighting equipment of a car by the car designer. After all other apparatus and equipment are taken care of, the lighting is considered and fitted as well as possible into the remaining space.

2 From a standpoint of practical consideration for the welfare of passengers, the lighting plays one of the most important parts; therefore, every effort should be made to arrange the light units so that no discomfort be occasioned, and to install the apparatus and wiring so that operating failures be reduced to a minimum. In this connection I might say that the United States postal authorities at Washington are going into this subject very carefully at the present time to insure fair treatment for their postal clerks in the railway mail service; very stringent requirements have been ordered both as regards general illumination and reliable performance.

3 The two essential considerations for the designing engineer to keep in mind in laying out his installation are:

a The arrangement of parts in a manner to allow of easy inspection and repair.

b Protection against mechanical injury.

Convenience and accessibility of apparatus, fixtures, junction boxes and wiring mean much to the inspector. It is a well-known fact that the average inspector will pay little attention to those parts which are difficult of access, and much better inspection work will result where parts are arranged in a get-at-

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able manner. It is of equal importance that the various parts be protected in such a manner as to avoid all possibility of injury to them while the car is in service. The other essential features of the lighting installation are discussed in the following paragraphs:

4 *Axle Generator.* The usual practice is to suspend the generator by swinging links at the inside end of the truck, and belt it to a pulley on the axle. For mounting the axle pulley a straight machined seat should be provided in all cases if electric lighting is planned or can be anticipated. Until recent years the universal practice was to provide the regulation tapered axle and allow the manufacturer of electric lighting equipments to adapt his pulley to an unsuitable seat in the best manner he could. The belt and pulley troubles which resulted were disproportionate to any possible advantage from retaining the tapered axles. It is customary for the manufacturer of lighting equipments to provide his own supporting structure adapted as circumstances permit for attachment to the truck. The resulting suspension is at best something of a makeshift.

5 It would be a consummation much to be desired if truck designers would provide a generator support built integral with the truck; the requirements are not difficult and it is certain that the generator builders would be glad to make their machines conform to the truck builder's suspension. As the matter is now handled, nothing causes them more delay and inconvenience than obtaining the numerous details of truck and underframe construction necessary for making an intelligent layout of the generator suspension. In designing the suspension it is desirable that the space required for the belt be kept as clear as possible. The end tie of the truck frame, if used, should not be deep and should be located at a level that will make it possible for the belt to straddle it. Outside brake beams when used are a necessary evil from the standpoint of generator location. Head room for the generator should be considered in laying out deep center girders, brake rigging and piping. All the open space that can be provided about the generator is desirable because it facilitates thorough inspection. The generator terminal board should be attached to the underframe of the car close to the generator and readily accessible.

6 *Battery Box.* On account of the obvious necessity for convenience in handling the heavy batteries, the battery box

location has practically been standardized. As the weight and dimensions of elements are almost identical, it is unnecessary to change the hanger design after a satisfactory arrangement has once been used.

7 *Charging Receptacles.* The charging receptacles have been allotted a permanent location on electric lighted equipment. Care should be taken to arrange the wire leading to the receptacles to prevent interference with brake rods, etc.

8 *Switchboard and Regulator Lockers.* (*a*) The switchboard locker should be so located as to be at all times easily accessible to the trainmen; no pains should be spared in the design and installation of the board; nothing but fireproof material should be used. A receptacle for spare lamps and a report card holder are convenient accessories. (*b*) The regulator locker is generally located under the switchboard and on the generator end of the car. Good ventilation is a necessity. Provision against dampness and dirt is imperative. The regulator lockers should be fitted with locks to guard against accidental or wilful interference with apparatus. In designing lockers for lighting apparatus it is recommended that liberal space be provided so that changing of equipment, repairing, inspecting and testing can be done to the best advantage.

9 *Conduit.* In steel-car construction, metal conduits are almost universally used. In the better type of steel car the interior conduits can be concealed behind metal molding and suitable outlet boxes designed to harmonize with the contour of the molding. Some designers are satisfied to have exposed conduit used exclusively throughout the car. In laying out wiring conduit, direct runs without sharp bends should be used. Care in locating the conduits will facilitate the installation of wires and prevent damage from moisture, etc.

10 *Fixtures.* Where side lighting is used, a satisfactory arrangement can be obtained by designing the fixture to meet the contour of the molding. In center deck lighting, it is advisable wherever possible to arrange the carlines so that a direct support to each fixture may be obtained. On platforms provision for one or two-lamp outlets is sufficient. A plain socket mounted on the platform ceiling has been used in some instances. A better arrangement would be a metallic reflector sunk flush in the ceiling.

11 *Emergency Lights.* It was formerly customary in applying electric light to retain gas lighting as a reserve. Increasing reliability of electric lighting apparatus has made this unnecessary and in the best present practice no gas equipment is provided. For emergencies it is customary to provide holders for candle lamps; but it is only on rare occasions that these have to be used, if the electric equipment is of a good modern type.

PROVISION FOR ELECTRICAL EQUIPMENT ON STEEL MOTOR CARS

By F. W. Butt,[1] New York

Non-Member

In providing for the electrical equipment on steel motor cars, several important points should be considered. On account of its metallic construction, the car becomes a negative conductor, or, in other words, the car is grounded, and all electrical apparatus must be well insulated against leakage of the electrical current.

2 Switches, circuit breakers, fuses, etc., should be so located that the arc when opening a circuit will not reach the metal structure of the car. In cases where space is limited, and it becomes necessary to locate circuit breaking apparatus in such a way that there is danger of the arc reaching the metal structure, suitable arc shields of non-conducting and non-inflammable material should be used.

3 Switches, terminals and other apparatus, having exposed live parts, should be protected against accidental contact by enclosing them in boxes or cabinets. This protection is most important where apparatus, such as mentioned above, is located in or near the space which is occupied by passengers.

4 It is sometimes found necessary on account of the restricted space in toilet rooms, motormen's cabs, postal and baggage compartments, etc., to attach electric heaters directly to the sheathing; the heater coils then are necessarily close to the sheathing, and as a means of protection to the paint and varnish thereon, an insulated backing should be applied between the sheathing and the heater.

5 Particular attention should be given to locking bolts, nuts,

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screws, etc., to prevent them working loose on account of vibration, especially those which are used to secure the apparatus. The vibrations of the motor gearing are transmitted to all parts of the car and they are more pronounced when the motor suspension lug is mounted on the truck transom, without the use of suspension springs. Vibration is more easily transmitted through the solid structure of steel cars than it is in cars of wood.

6 In the design of new cars it is sometimes found convenient to locate various members of the structure, especially in the underframe, so the apparatus can be suspended from them without the use of intermediate supports. This is desirable, as it is often found that many parts can be omitted from the car. Where heavy apparatus is to be suspended from intermediate supports, large heavy members are required, sometimes complicated in design in order to obtain clearance between parts of the structure or apparatus.

7 Where it is possible, apparatus hangers should rest on the members which support them and not depend entirely upon a vertically bolted or riveted connection. The hangers should be well braced, especially those which hang far below the underframe, to prevent swaying of the apparatus, due to the motion of the car. The hangers can be so designed as to provide the necessary bracing, but to accomplish this odd shapes are often required which increase the cost of manufacture. It is then desirable to provide hangers and separate braces of simple design.

8 When several switches, fuses and other electrical apparatus are required for the motor, control and auxiliary circuits, large switchboard area is necessary, and in some instances, the switchboard has been installed in one of the end bulkheads, occupying most of the space between the body corner and door posts. In recent steel cars, intermediate body end posts are used as part of the general scheme for anti-telescoping provisions at the end of the car. These posts extend from the body-end sill to the body-end plate, and it is recommended, in order to interfere as little as possible with the general anti-telescoping scheme, that two small switchboards be used, one placed in the bulkhead on each side of the body-end door opening, and located as high above the platform as the size of the boards will permit. This arrangement of switchboards provides for the use of short inter-

mediate body-end posts, extending upwards from the body-end sill to the horizontal frame member, located just below each switchboard and connected to the body corner and door posts.

9 In wooden car construction it is necessary to provide ground wires from the various electrical circuits to some part of the car which is a negative conductor. This is unnecessary on cars of steel construction, as the electrical circuits can be grounded at almost any part of the car structure.

10 The steel car is safer than cars of wood construction, as there is no danger of bad fires on account of short circuits. Parts of the structure of a steel car will not become alive, as is sometimes found in cars of wood construction.

11 The wiring conduit on a steel car should be provided for at the time the car is being designed. Unless this is done, difficult bends in the conduit may occur and it is sometimes found necessary to cut and reinforce the structural members.

AIR BRAKES FOR HEAVY STEEL PASSENGER CARS

By A. L. Humphrey,[1] Wilmerding, Pa.

Non-Member

Advancement in the development of air brakes has been no less contingent upon the development of rolling stock than the economic handling of traffic through the use of heavier and faster trains is contingent upon the advancements in motive power. A review of the history of railroad transportation development in this country will show a steady and unceasing advance from year to year. Equivalent advancement in the efficiency of appliances such as air brakes was consequently necessary in order that the control and safe handling of longer and heavier trains should not operate as a barrier to these developments.

2 A brief comparison of the conditions existing at the time of the introduction of the air brake with the conditions at present, will show that the advancement in rolling stock has been more rapid than those who have not been in close touch with the situation are likely to realize. For example, the weight on drivers of high-speed passenger engines has increased from 25,000 to 180,000 lb. The drawbar pull of locomotives has increased from 7,000 lb. to 30,000 lb.; working steam pressure has increased from 125 lb. to 225 lb.; weights of passenger cars have increased from 20,000 lb. to 150,000 lb. The schedule speeds of passenger trains have increased from 30 miles per hour to 65 miles per hour, and it is not uncommon for speeds to reach as high as 85 to 90 miles per hour.

3 Taking the average weights of trains and average speed at the time the air brake was introduced as compared with the

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trains and speeds of today, the weight per vehicle has not only increased nearly eight times, but the foot-pounds of energy to be destroyed is nearly 15 times as much. In order to meet the demands of modern service conditions as efficiently as heretofore, means should be provided for dissipating the total energy stored up in this swiftly moving mass in at least as short a time and distance as before. In fact it is desirable to do this in as much less time as is consistent with comfort to passengers and accuracy of control, in the case of service stops, and in as much shorter distance or time as may be possible in the case of emergency. Not only must the brake be automatic in its operation, but it must be capable at any time and under any conceivable circumstances to produce the maximum possible retarding force within as short a period of time as the known resources available and physical limitations will permit.

4 When we consider that it requires a distance of 8 to 12 miles for a locomotive of modern design, hauling a train of say ten cars, to accelerate to a speed of 80 miles per hour and that this same train should be brought to a standstill within the shortest possible time—or say in one-tenth of the distance required to accelerate to this speed—it is hardly conceivable that this can be done with the means available, which is a retarding force produced by frictional contact of metal shoes against the wheels, which is in turn limited by the adhesion between the wheels and the rail.

5 This factor, viz., the friction obtainable between wheel and rail and shoe and wheel is the basis on which we must start, and upon which we are limited, as to the amount of retarding force obtainable. It is therefore of first importance in designing an air-brake installation to give due consideration to the contact between the wheel and rail and the possible efficiency of the brake shoe. The air brake in itself is practically limitless in the amount of force obtainable, but the practical application of this force is where the line must be drawn. In this connection it is worthy of note that the brake shoe today has about four times as much work to do as it had 30 years ago. The chief effect of this, however, is to destroy the brake shoe at a much more rapid rate, without permitting any material lengthening of stopping distance.

6 The improvements made in air brakes in recent years, which have made it possible to control the present heavy high-speed

passenger trains with approximately the same degree of efficiency as the older forms controlled the equipment of their day, have been based on scientific principles and experience in obtaining reliable information and data. The matter of time of transmission of compressed air was not so important a factor with the shorter trains and slower speeds as it is today, where a train running at 80 miles per hour passes over a distance of 117 ft. per sec.; consequently a few seconds saving in the time of getting the brakes to fully apply is just so much relative gain in the time and length of stop. With the latest improved pneumatic equipment, the maximum brake cylinder pressure can be obtained throughout a modern train of ten cars in 4 seconds, which is the shortest possible time that this can be obtained by serial quick action through a train of this length. For the purpose of shortening this time serious consideration is being given by some railroad officials to the type of brake equipment used on the New York subway, and known as the "electro-pneumatic," which would not only tend to cut the time of full application in two, but by means of the electric control all brakes are applied simultaneously, which not only assists in shortening the stop but in preventing shocks, etc.

7 Another equally important factor now coming more prominently into use is the application of brake shoes to each side of the wheel, known as clasp brakes. The virtue of clasp brakes, however, is not so much in the aid they afford in shortening the stop as in the equalizing effects of pressure on the wheels, journal box bearings and trucks, the minimizing of lost motion which affects the brakes through increased piston travel, and the less tendency toward wheel sliding while the brakes are applied.

8 While a comparison of the relative merits of a brake equipment, as with most mechanical devices, is frequently based on their maximum capacity, it must be borne in mind that an air-brake equipment must be designed to include flexibility for service operation, in which it is operated 99 per cent of the time and during which time it should be capable of handling smoothly the extreme lengths of trains, while at the same time it must be capable and ready under all conceivable circumstances to produce the maximum permissible braking force in case of an emergency.

9 It is not especially difficult to increase the speed of a train from 30 to 40 miles per hour, but it requires a vastly greater

amount of energy to increase the speed from 60 to 70 miles per hour. In like manner, for any given increase in speed, the additional amount of work required of the brakes increases proportionally. If, therefore, the brakes for the heavier trains and higher speeds of today permit of stopping in about the same distance and with the same flexibility of control as could be done with brakes 40 years ago, and with the trains of that period, it is at least gratifying to know that the advancement made in this particular line of railroad development has kept pace as closely as it could consistently with the development in transportation facilities, through which its rate of advancement is largely controlled.

CAST-STEEL DOUBLE BODY BOLSTERS, PLATFORMS AND END FRAMES FOR STEEL CARS

By C. T. Westlake, St. Louis, Mo.

Member of the Society

Cast steel as applied to underframes and end frames of railroad cars is the result of careful design and painstaking, and thorough development of the art of casting in sand molds. These large steel castings are made in baked molds, confined in massive metal forms, by a special method that assures positively against swelling due to pressure of the inflowing metal, and yet permits yielding to the pressure of the contracting metal when cooling, so that the castings are very accurate in shape and close to size, and are free from shrinkage stresses.

2 Steel is an alloy of iron and carbon and differs from other alloys of iron by being capable of developing all its physical properties to the maximum degree. Its most distinctive properties are rigidity, ability to stand maximum forces without yielding; elasticity, ability to return to normal after being loaded to deflection; ductility, ability to stand distortion beyond its elastic limit without fracture; malleability, permitting it to be forged; tensility, high tensile strength; and weldability, permitting it to be welded by heating and hammering. These properties which steel possesses in a maximum degree distinguish it from all other alloys of iron.

3 Cast steel and rolled steel are produced by the same processes and of the same materials, are of the same chemical composition and have the same physical properties, and cast steel may be substituted for rolled steel, using the same fiber stresses, and its substitution is limited only by the minimum section that can be poured in the molds.

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4 As recently as 1893, cast steel was comparatively unknown in car construction, and in that year its introduction began in the use of truck bolsters for freight cars. This was followed a few years later by body bolsters or transoms, and it was only after their use on freight cars had demonstrated satisfactorily the reliability of the material and design, that attention was turned to passenger cars.

5 The double body bolster was first to receive consideration for passenger cars, and although, due to casting difficulties, its weight was at first excessive, it was quickly refined and assigned to its proper place with other cast-steel articles. It was found to be so much lighter, stronger and permanently effective than the built-up type, by forming a one-piece cradle or support for each end of the car body, that its use soon became almost universal in construction of passenger cars.

6 As the demand increased for stronger, safer and less combustible cars, the problem of replacing wood with steel developed many difficulties. The wooden car was the result of many years of experimenting, of cutting and trying with a material easily worked, but as one of the most valuable properties of cast steel is its adaptability to combining a multiplicity of complex parts into a single one of simple form, it was gradually developed from the double body bolster form, first to include end sills, then end and buffing sills; next the end and buffing sills were combined with longitudinal members extending to, and connecting with the double body bolster. Finally these parts, together with many others combined into a single simple member at each end of the car underframe, and comprising so many of the fixed parts that it is now only necessary for the carbuilder to connect them by center girders and to apply draft and buffing gears and the superstructure to complete the car frame.

7 The ideal underframe should have all connecting members in the same plane so as to avoid buckling due to eccentric loading; it should be so designed that each member will independently perform its individual functions, passing the stresses from one member to the other through the smallest number of properly aligned connections; and all should be so arranged in relation to each other as to form one powerful, compact, shock-absorbing element throughout the length of the car.

8 This can be accomplished to great advantage in cast-steel construction since the metal can be properly distributed in pro-

portion to the stresses. The gusset plates can be placed in the same plane as the flanges of intersecting members, and the whole reduced to minimum weight and to the smallest number of parts with practically no joints. It can be molded to any desired conformation, can be shaped to any curve, useful or ornate, without the use of expensive dies, can be provided with necessary projections joined to the main members by proper fillets. Openings may be provided with finished and reinforced edges, and all parts may be molded to symmetrical, pleasing contour, all edges rounded and a complete, practical, operative device, emanating from a single source furnished to the carbuilders ready for application.

9 As the rounding of curves necessitates the use of convex ends to the car body, the central portion of the ends is most exposed and liable to receive initial impacts, and this portion should be made strongest and most capable of properly transmitting the force of impacts to the balance of frame.

10 The underframe receives the force of end collision as a column load on its longitudinal members, while the end frame receives it as a transverse load on exposed members supported at their ends. As it is impracticable under these conditions to make the end frame equally as strong as the underframe, provision should be made for protecting the end frame against destructive forces. The underframe should be arranged so as to receive the initial impact, and if the encountered force is sufficient to destroy it, it should fail in such manner as to form additional protection to the end frame.

11 This is accomplished in cast-steel construction by arranging the parts of the longitudinal members so that when loaded to destruction by a collision force, the end portions yield upwardly, thus folding the exposed portion of the platform up against the end of the car body, and forming an addition to the end frame to assist in distributing the force to all the longitudinal members of the superstructure. The advantage of this construction has been demonstrated in wrecks when this identical action has taken place, the safety of passengers assured, and the property loss kept low.

12 The cast-steel platform as now provided for blind end cars, comprises the buffing sill having recesses for the buffer foot plates, holes and brackets for the buffer stems, pockets for the buffing device, brackets for safety chains, lugs for draft gear,

brackets for drawbar carry irons, anti-telescoping plate, extensions of the center sills and bottom chords of the side sills, all of the double body bolster members including side bearing arches and extending for a distance of over 14 ft. inward from the end of the car to a point considerably back of the truck center, and counting rivets, gusset plates and connecting angles, combining more than 1000 pieces into a single, powerful, shock-absorbing element of less weight than fabricated material of the same strength.

13 The cast-steel platform and double body bolster for vestibule cars comprises all the parts enumerated for blind end cars, and in addition, includes the exposed platform longitudinal members, step risers and end sill, measures over 17 ft. in length, is made of a single piece, and is also of less weight than fabricated material of the same strength.

14 Since the government has taken a hand in the construction of cars used in its service, stronger body end frames are being used, and as the end of the car is the first to encounter end collision forces, it reasonably deserves closer and more careful consideration.

15 Most damage is produced by end collisions and to protect life and property from them, the colliding object must be prevented from entering the car. To accomplish this, the end frame and end portion of underframe should be constructed so as to distribute the force of collision into all the longitudinal members of the car, passing it into the largest mass, utilizing every particle of available inertia to absorb the force without permitting it to reach and act upon the contents or occupants of cars.

16 The end frame proper should be designed so that when a single member is loaded, all will act with it, and this can be accomplished only by connecting them so as to form a single mass, and best by forming them in a single piece as in cast-steel construction.

17 In designing the cast-steel end frame we assume it to be a beam supported at its upper and lower ends and loaded at a point about 18 in. above its lower end. We provide connections between the end frame and balance of car frame of sufficient value to develop the full transverse strength of the end frame; the vertical members of end frame are connected by horizontal members so that in case the end frame is loaded to destruction the connections are sufficient to disrupt all the longitudinal mem-

bers of the car frame, and when they yield all parts will be forced toward the center of the end of the car and tend to prevent one car telescoping the other.

18 Cast-steel parts weigh less than built-up members carrying the same load since the metal in castings can be properly distributed in proportion to stresses. In built-up construction the metal overlaps at the joints and this, together with the rivet heads, makes an additional weight which in cast construction is avoided. In the latter, reliance is placed in a single solid member and, as there are no joints, there is no chance of their being imperfect or becoming loose.

19 The advantage in cast steel to the carbuilder is also very great. To produce a platform of the built-up type at least eight different classes of material are required. This comes from eight different manufacturers, frequently from as many different points of production, much of it in less than carload lots, and all has to be requisitioned, purchased, received, stored and recorded for use on each particular lot, and in order to reduce storage space and avoid congestion in the car plant, all deliveries have to be carefully and accurately timed, and followed up. Then each material has to be passed through the different departments of the car plant to be cut, shaped, punched, drilled and the same timing and tracing methods used, so as to have all parts completed at the proper time. When cast steel is used but one material is purchased from a single plant, only one piece is handled, that in carload lots, and when it arrives it is immediately ready and available for application without storage or re-handling, facilitating completion of the car by leaving more car plant machinery available for other work.

20 A plant capable of producing castings of this nature in quantities to meet requirements of the many car plants must have buildings of extensive area and equipment in proportion, as it ordinarily requires about ten days for a casting to pass through the various processes of casting, cooling, roughing, cleaning and machining, and an accumulation of ten days' output has to be constantly accommodated. All handling and conveying apparatus must be in duplicate so as to insure uninterrupted operation and machines for finishing must be of the highest grade and maintained in perfect condition to produce accurate and proper results.

21 In car construction cast steel stands preëminent as the best

material for reducing to the minimum the weight and number of parts while maintaining requisite strength and other essential properties, and its popularity and use will proportionately increase as its benefits and advantages become more generally recognized.

SPECIAL ENDS FOR STEEL PASSENGER CARS

By H. M. Estabrook,[1] Dayton, O.

Non-Member

After the passenger car had emerged from the stage-coach type of construction the box-like shape of car was introduced with straight longitudinal floor sills and with straight vertical side and end posts. These members were of wood, the ends of the longitudinal floor sills being tenoned into mortises in the wooden end sills. The vertical side and end posts were in like manner tenoned into the side and end sills at their lower end and likewise into the wooden side and end plates at their upper ends. These side and end posts were maintained in their several positions, by wooden spacing blocks or bridging, and the whole structure tied together by means of iron rods and bolts. These spacing blocks served further the double purpose of affording a foundation for securing the outside panels and the wooden interior finish.

2 Several types of roof were quite prevalent in early passenger car days, among them being the round top or omnibus roof, which has again made its appearance in steel passenger cars in some parts of our country. Another type of roof was the Ogee, or turtle-back, and later came the monitor, or raised deck roof. The prevailing type of hood projection over the platforms was the "duck's bill" type, as illustrated in Fig. 1, which also furnishes a good idea of the framing employed in those days. Fig. 2 shows end framing of these same cars.

3 A little later the projecting platform hood was changed from the "duck's bill" type to the bull-nose type. Figs. 3 and 4 show respectively a longitudinal section and exterior of these cars. Fig. 5 shows the end construction and Fig. 6 the standard framing employed in the first bull-nose hood cars

[1] President, Barney & Smith Car Company.

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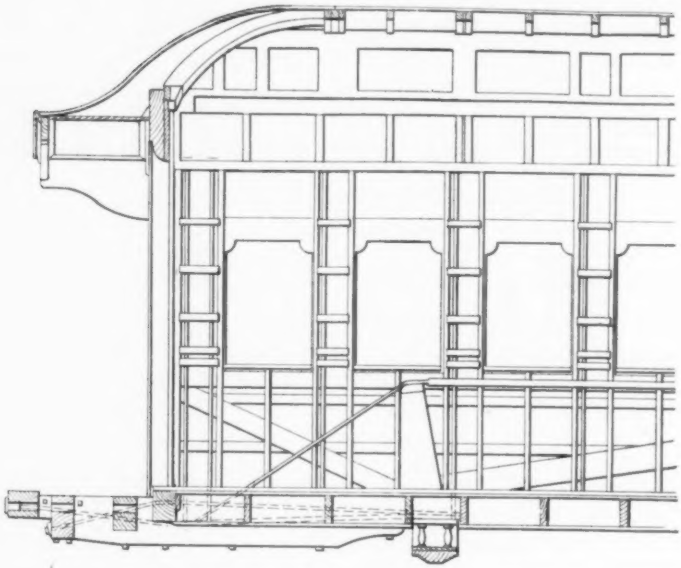

FIG. 1 "DUCK'S BILL" TYPE OF HOOD PROJECTION OVER PLATFORM

FIG. 2 END FRAMING FOR "DUCK'S BILL" HOOD PROJECTION

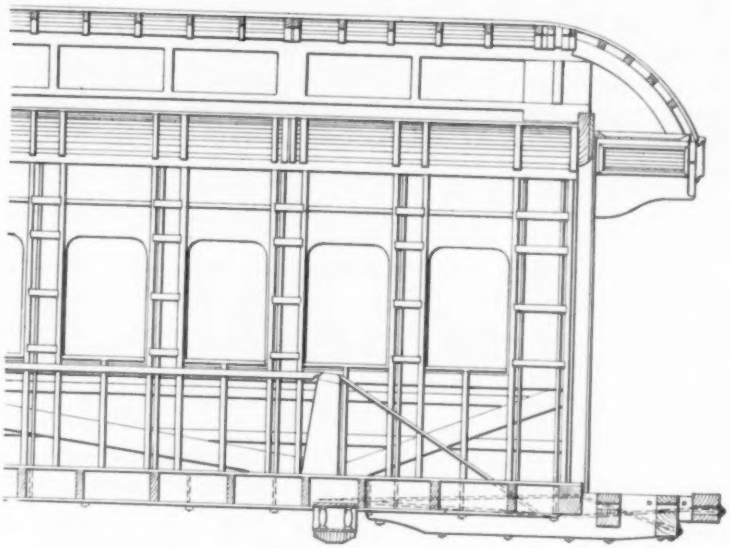

Fig. 3 Section of Bull-Nose Type of Car

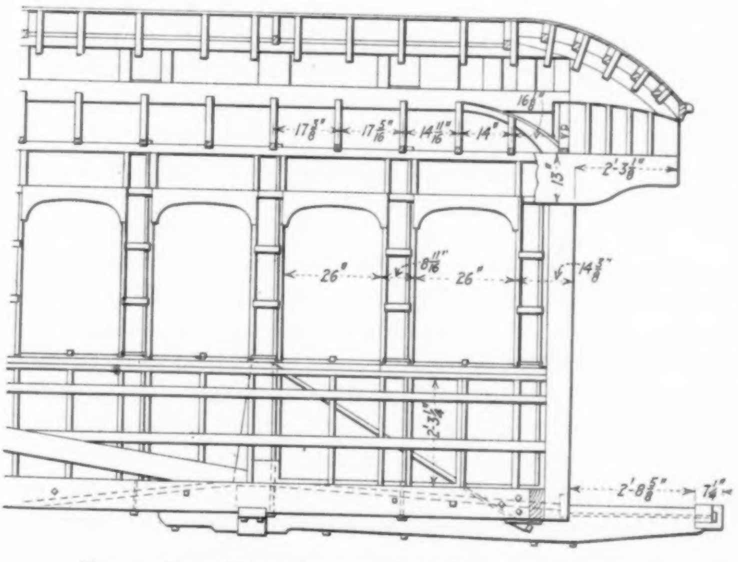

Fig. 4 Bull-Nose Type of Car, Framing Exposed

in the early eighties. Up to the middle eighties no systematic attempt had been made to strengthen the ends of cars. The platform members were all of wood and the end framing of the car had not experienced much change in the way of strengthening from the earlier types. With the advent of the narrow vestibule in 1887, which was immediately followed by the broad vestibule in 1888, came the demand for a stronger end.

4 About the year 1890 there was brought into use what was

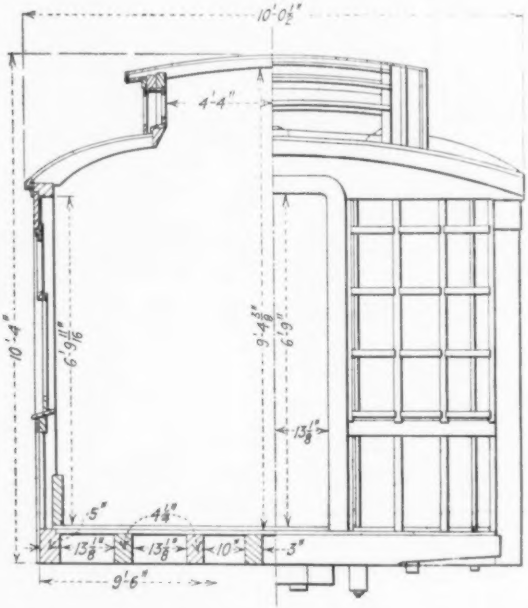

Fig. 5 End Construction of Bull-Nose Type of Car

known as an "anti-telescoping" end framing. This construction consisted of double side and end sills with a steel plate 8 in. by ½ in. from 18 to 24 ft. long, sandwiched into the double side sill, with the end of these plates turned so as to form a foot against the end sill. The double end sill had a steel plate 8 in. by ¾ in. and the length the width of the car, sandwiched into the end sill. The end posts of the car were reinforced by steel bars 3½ in. by ¾ in., extending downward through and bolted through the sandwiched end sill and having their upper ends extending upward and bearing on and bolted through a steel plate 6 in. by ⅜ in., which was bolted to the oak end plate of

the car. This stiffening plate extended across the width of the car and the ends of the steel plate being turned so as to form a foot upon the side plate of the structure. This anti-telescoping construction is illustrated in Fig. 7. This design of end framing came into general use throughout the country and is in use today in the majority of wooden passenger cars built since 1890. It is interesting to note that this anti-telescoping framing is the same, with some modifications and additions, as was adopted by the United State Government for the construction of full postal cars and known as Specification No. 1.

5 Somewhat later this type of end framing was elaborated upon by the use of a heavy steel angle flitched into the end sill, with the end still further reinforced by a 20 in. by ½ in. steel gusset plate on the under side of the sills, and by the use of steel Z-bars in the end posts and a heavy steel angle introduced into the construction of the end plate of the car.

6 The increased weight of the vestibules and anti-telescoping end framing developed the necessity for a stronger platform construction than the old style wooden platform member that had been used for many years. About the year 1895 the standard steel platform, composed of steel I-beams, came into general use, and was employed continuously until the advent of the steel car superseded it by other designs.

7 Notwithstanding the frantic efforts of Congress toward the general adoption of steel passenger cars, it has been stated upon reliable authority that no vestibuled wooden passenger car, in the construction of which was employed the anti-telescoping end framing, in a straight-on end to end collision (although frequently having the ends concaved) has ever had the end crushed in to the extent of the adjoining car body telescoping and entering it.

8 The United States Government in seeking to strengthen the end construction of postal cars adopted this form of anti-telescoping end framing with the addition of two 7-in., 23.46-lb. steel bulb beams on either end of the car. These bulb beams have their flat base resting against the outside of the reinforced end posts of the car, being located in line with and immediately behind the vestibule diaphragms and face plate. At its lower end, this bulb beam has the head and web notched out with the base flange extending downward through the flitched end sill, the main body of the beam resting upon the 1 in. thick steel plate

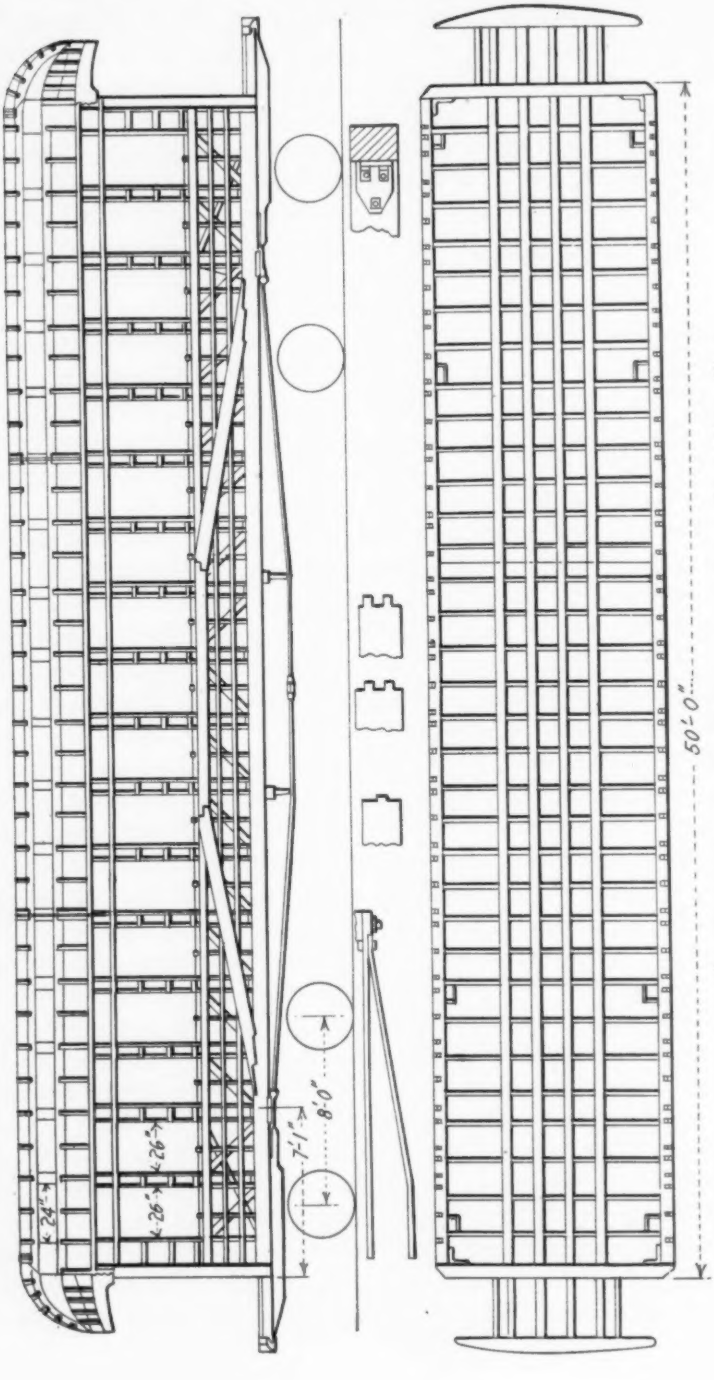

Fig. 6 Standard Framing employed in First Bull-Nose Cars

on top of the buffer beam. At the upper end these bulb beams have the web and bulb head sheared diagonally so the base flange extends upward on the outside of the end plate of the car framing, and through this flange passes the top piston stems of the vestibule mechanism. This type of construction is now obsolete

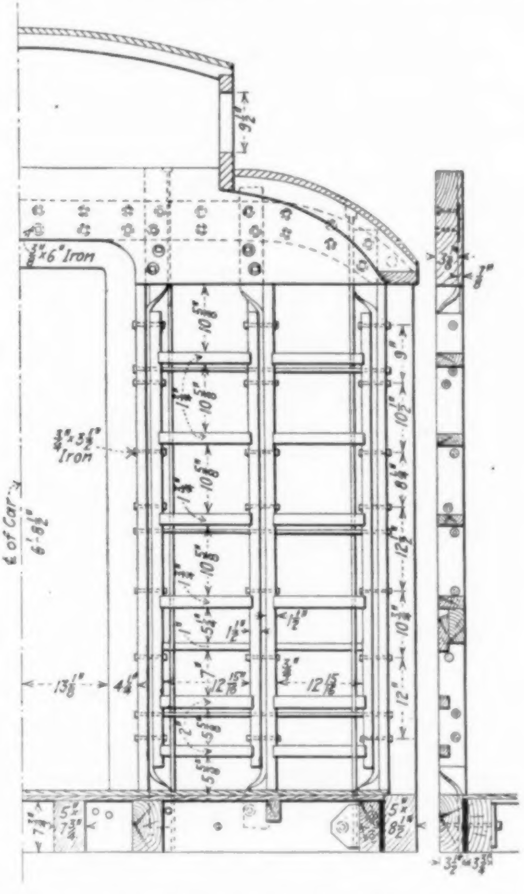

FIG. 7 ANTI-TELESCOPING IRON END FRAMING

in postal cars, Congress having enacted a law requiring them to be of steel construction.

9 When the steel passenger car made its appearance about the year 1905, the passenger car entered a period of transition and evolution from which it has not yet entirely emerged with a recognized standard form of construction. The wooden car

had attained a degree of uniformity that established it as an accepted standard. In the construction of the early steel passenger cars, as was probably natural, an attempt was made to follow closely the lines employed in the construction of wooden cars, with the result that the first steel cars were inferior in strength of end construction to the prevailing wood construction, but

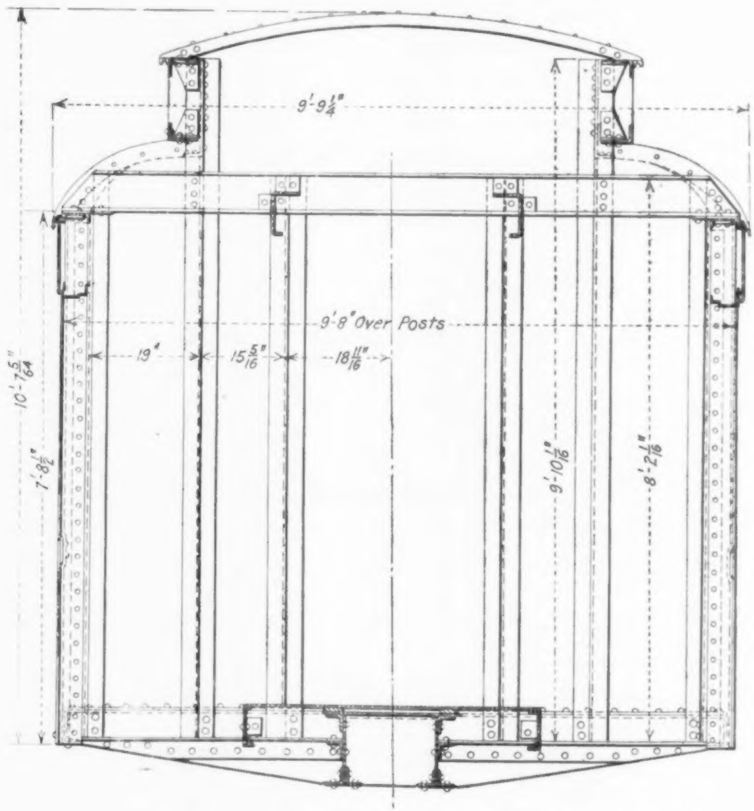

Fig. 8 Body End Framing, Type shown in Fig. 9

the evolution has been rapid, one improvement following close upon the heels of another. In the entire history of car building, there has probably not been devoted so much concentrated thought and study to the improvement in design, by the most expert engineering talent of the railroads and car builders, as has been shown since the introduction of steel cars. This has resulted in rapid improvement of end construction until we

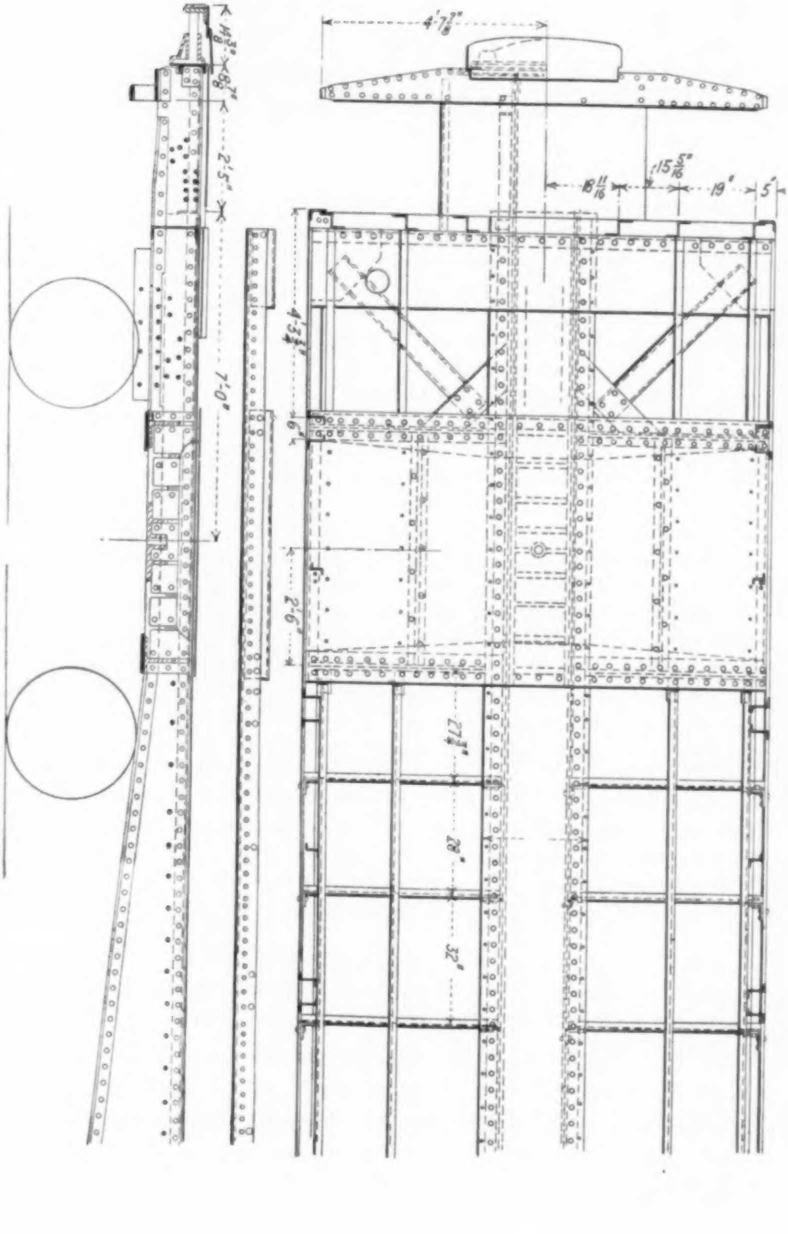

FIG. 9 STEEL CAR CONSTRUCTION, CENTER SILLS EXTENDING FULL LENGTH OF CAR

have today reached a design that is considered practically standard. This development has no doubt been hastened by the action of Congress relative to steel postal cars and the coöperation of committees of the railway mail service, the railroads and the car builders, to the end that a standard specification for the strength of the various parts of the car, and especially the end construction, has been adopted by the Postoffice Department in which it is provided that:

The maximum end shock due to buffing shall be assumed as a static load of 400,000 lb. applied horizontally at the resultant line of forces acting as the center line of the buffing mechanism and at the center line of draft gear, respectively, and shall be assumed to be resisted by all continuous longitudinal underframe members below the floor level, provided such members are sufficiently tied together to act in unison.

The sum of the section moduli of all vertical end members at each end shall be not less than 65 and the section moduli of the main members, either forming or adjacent to the door posts, shall be not less than 75 per cent. of this amount. The horizontal reactions of all vertical end members at top and bottom shall be calculated from an assumed external horizontal force, applied 18 in. above the floor line, to all vertical members in the proportions given, such force being of sufficient amount to cause bending of all vertical members acting together, and top and bottom connections of vertical members shall be designed for these reactions. Except where vertical end members shall bear directly against or be attached directly to longitudinal members at either top or bottom, the assumed reactions shall be considered as loads applied to whatever construction is used at end sill or end plate and both these last named members shall have section moduli, respectively, sufficient to prevent their failure horizontally before that of the vertical end members. All parts of the car framing shall be so proportioned that the sum of the maximum unit stresses to which any member is subject shall not exceed the following amounts in pounds per square inch—these stresses, unless otherwise stated below, are for steel having an ultimate tensile strength of from 55,000 to 65,000 lb. per sq. in.:

Bolsters of Rolled Steel—Stress shall not exceed 12,500 lb. per sq. in.

Sills and Framing of Rolled Steel—Stress shall not exceed 16,000 lb. per sq. in.

When cast steel is used the allowable stresses may be the same as for rolled steel except tension stresses, which must be at least 20 per cent less than those allowed for rolled steel, as specified above.

10 To meet these requirements, there are at this time three distinct forms of construction employed: The one most generally employed is illustrated in Figs. 8 and 9, which is composed of rolled-steel sections with the center sills running the full length of the car from buffer beam to buffer beam. Another type is that in which the rolled steel center sills connect at the bolster with a steel casting, forming a combined body

bolster, center and side sills, and end sills, as illustrated in Figs. 10 and 11. Another type is that in which the rolled-steel center sills connect at the bolster with a steel casting, forming a combined body bolster, center and side sills, end sill and the entire end frame of the car, as illustrated in Fig. 12.

11 In the first form of construction, shown in Figs. 8 and 9, rolled sections are employed entirely. The members forming the center sill construction extend the full length of the car from one buffer beam to the other and all other longitudinal members, such as side sills, belt rail, etc., extending the full length of the car body and in the case of vestibuled cars, the rolled section side plate extends the full length of the car from one vestibule corner post to another. The end sill is usually composed of pressed or rolled shapes riveted to the center-sill construction and extending laterally outwards to the sides of the car, the ends of the side-sill members butting against and being riveted to these end-sill members. The upper end plate of the car is composed of rolled or pressed sections extending in one piece across the width of the car and attached to the longitudinal side plates by connecting angles and gussets. To this end plate are also attached the longitudinal members of the upper deck sides. The end posts are rolled or pressed sections, usually Z-sections, extending downward to the bottom line of and riveted to the end sill. The upper ends of these posts extend upwards to the top line of and are riveted to the end plate. The nose piece or buffer beam is composed of rolled channels with their flanges turned inwardly towards each other, presenting their smooth surfaces on the outside, these channels being formed to suit the contour requirements of the vestibule, the channel members forming a box construction with top cover plates.

12 This buffer beam extends across and is riveted to the outward ends of the center-sill construction, from which it will be observed that the purpose of this design is to transmit the end buffing shock to the center-sill construction. The vestibule corner posts are rolled channel or Z-sections, whose bottom ends extend down into and are riveted to the outer ends of the buffer beams and whose upper ends are riveted to the vestibule end plate and to the upper longitudinal side plate of the car body, which projects beyond the end of the car body to meet and to connect with this vestibule corner post. The center vestibule posts are 6-in. I-beams whose lower ends extend downward

through and are connected to the buffer beam member and whose upper ends extend upward to and are connected to the vestibule end plate steel angle. Between the upper ends of these center vestibule posts and the end of the car body, are longitudinal compression members in the form of steel channels or angles. These rolled section corner posts, door posts and vestibule door

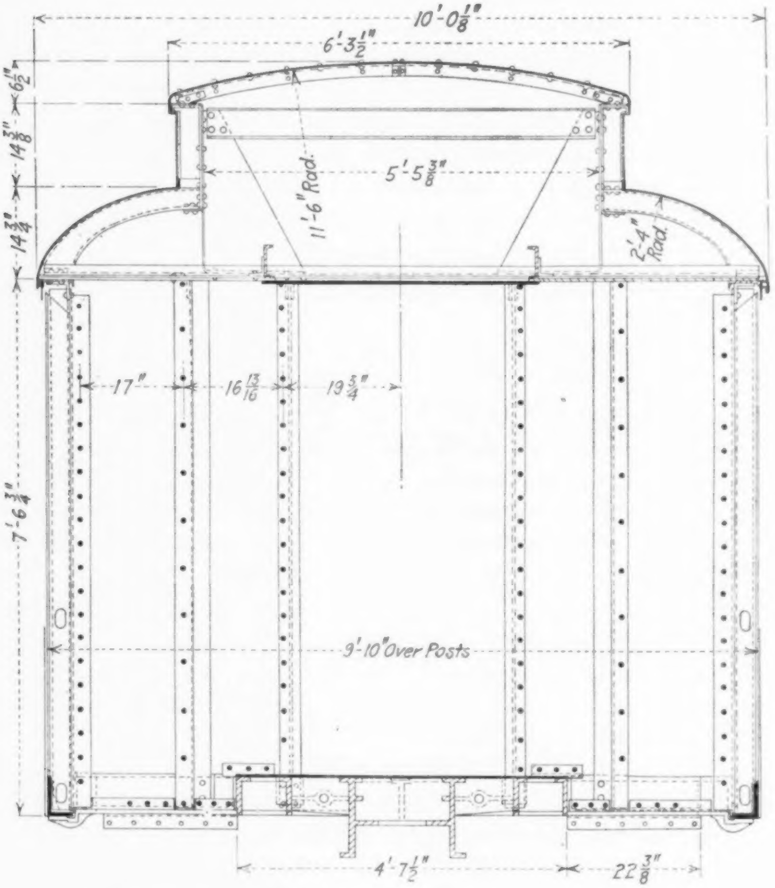

FIG. 10 BODY END FRAMING, TYPE SHOWN IN FIG. 11

and corner posts, are encased in light steel casings formed to give them the finished appearance of the same members in a wooden car.

13 In stub-end cars of this type of construction, the buffer beam is of considerably heavier construction than in the vesti-

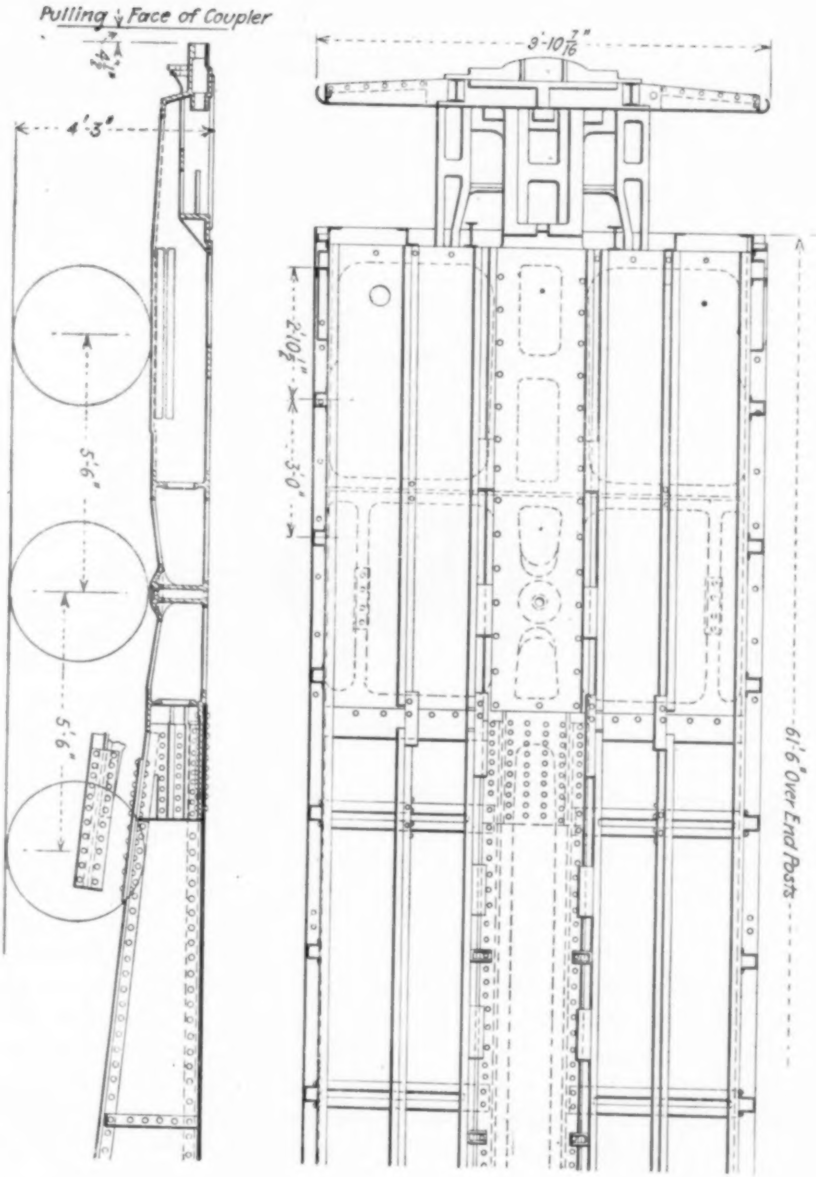

FIG. 11 STEEL CAR TYPE, CENTER SILLS CONNECT AT BOLSTER WITH A STEEL CASTING

bule car, and is usually composed of a built-up box construction or a one-piece steel casting, this buffer beam being secured immediately to the outside face of the end sill. In this construction there is usually employed a much heavier vestibule center post than in the vestibuled car. These vestibule posts, usually being a 12-in. I-beam, are located immediately in line with and behind the vestibule diaphragm and face plate. The end-post construction is much the same as described for the vestibuled car, there being a difference, however, in the construction of the end plate, which in the stub-end car is a pressed channel section

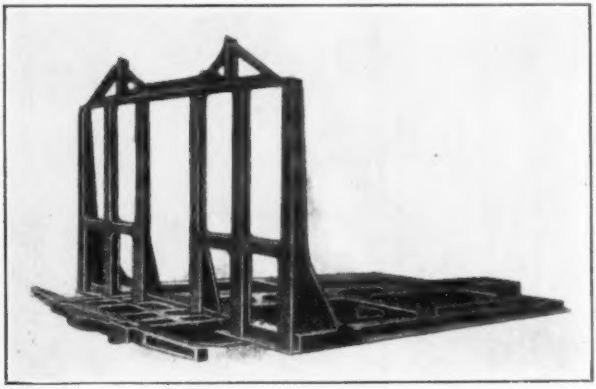

FIG. 12 INTEGRAL STEEL CASTING USED IN END FRAME CONSTRUCTION

formed to suit the contour of the car end, this channel end plate being placed across the end of the car in a horizontal plane, and into and riveted to this channel end plate are the upper ends of the corner posts, end posts and vestibule posts.

14 In the second type of construction referred to, a steel casting is employed forming the body bolster and platform to which the center-sill construction is riveted to this steel bolster. This construction is illustrated in Figs. 10 and 11, from which it will be observed that the center sill construction, the end sill, platform and buffer beam are all embodied in one steel casting. The end-post construction, the corner posts, vestibule corner and center posts are practically of the same construction as described for the built-up type, the difference being in the method of attaching the lower ends of these posts. The steel casting have openings or pockets in the end sill and buffer beam members, in which the lower ends of these posts rest and are riveted to the

casting. The construction of the end of the car body, the vestibule and hood are substantially as described for the built-up construction.

15 This type of construction for the stub-end car is substantially the same as that just described, the exception being that the steel bolster and end-sill casting takes the place of the built-up type of center and end-sill construction, the end post, corner post and upper end construction being identical in the two types.

16 In the third type of construction referred to the entire bottom framework of the car from the bolster outward to the platform and buffer beam, is one integral steel casting, and the entire end framing of the car is one integral steel casting, as illustrated by Fig. 12.

17 In referring to the three types of construction just outlined, it must be understood that reference is made to them only as types, and no attempt is made to describe the construction of any one railroad or carbuilder in particular, or to undertake to establish any of the forms described as being a standard, as the details of construction vary to a considerable degree with different railroads and builders.

18 It is of course apparent that the weight of the steel car is much greater than a car of the same size of wooden construction, and that the wooden car possesses in itself a natural elasticity to absorb buffing shocks such as are produced by collision that the steel car does not furnish. Hence, in the development of the steel car, with the enormous increase in weight of trains and the high speed at which they run, there has been a growing tendency to increase the strength of the structure with the view of making it as nearly indestructible as possible in order to compensate for the absence of elasticity. It is also apparent that, notwithstanding the strength of the structure, if it encountered an opposing force of sufficient magnitude, it might be annihilated, and so this strengthening process, and the increasing weight and speed might go on indefinitely without furnishing the result sought for. It is equally true that if the structure is designed for such strength as to be indestructible, when the two opposing forces meet, the movable objects within the cars, which is the human load, must suffer the damage. To avoid this possibility the idea has been evolved to construct that portion of the end of the car between the end of the main body and the vestibule face plates, these members being all such parts as are embraced in the platform, vestibule and hood covering the

vestibule, so that it will collapse under a less shock than would be required to crush in the end of the car body itself.

19 This idea is based on the theory that in a train in which there are say ten vestibuled cars, there is the space between the main bodies of each two coupled cars occupied by the platforms

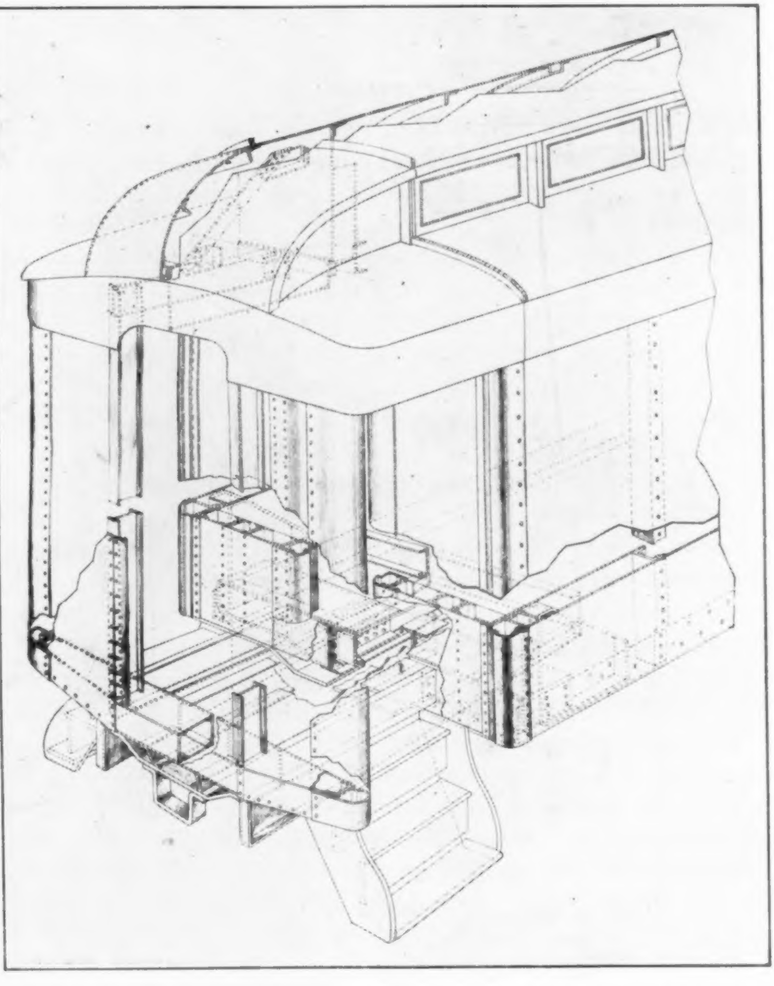

FIG. 13 COLLAPSIBLE VESTIBULE CONSTRUCTED ENTIRELY OF STEEL

and vestibules of approximately 8 ft., or in a ten-car train a space of approximately 80 ft., of shock absorbing space, which, if properly utilized in the instant of collision, would remove to a large degree the shock and resultant damage to the car body

itself and likewise lessen the possibility of damage to the persons of the passengers. From this idea has developed what is termed a collapsible vestibule. It is generally conceded that if

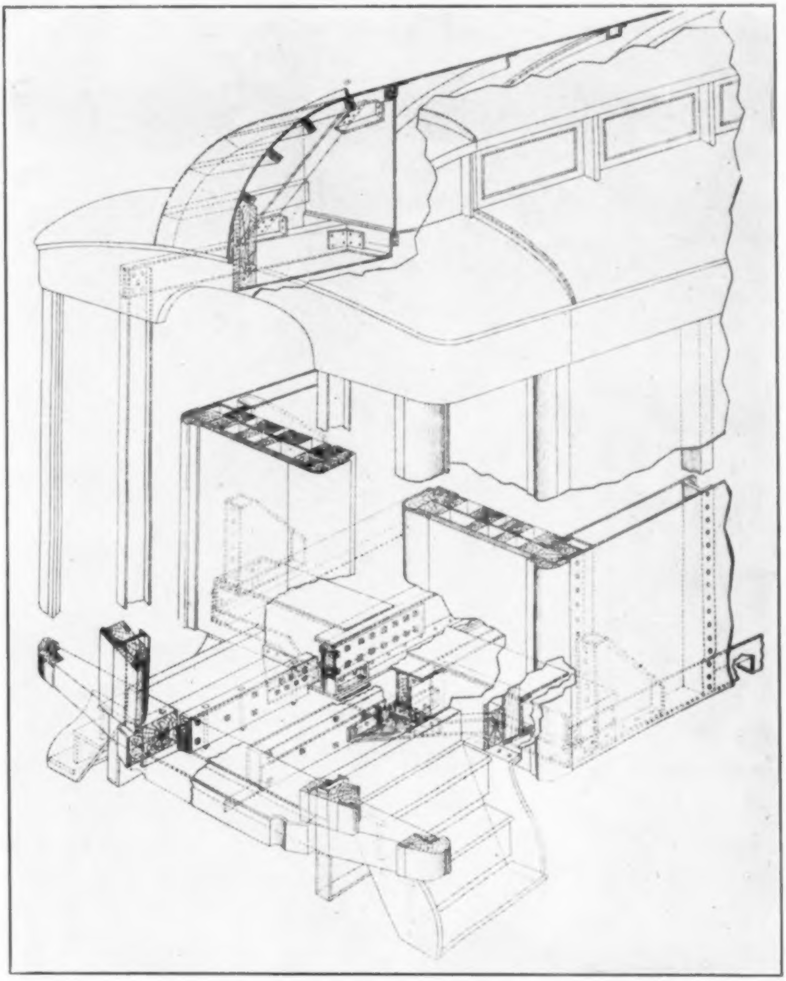

FIG. 14 COLLAPSIBLE VESTIBULE MADE OF A SERIES OF WOODEN POSTS TO SECURE ADVANTAGE OF ELASTIC AND CUSHIONING PROPERTIES OF WOOD

two vestibuled cars coupled together could maintain their respective horizontal planes at the instant of shock due to collision, there could be no telescoping and that telescoping is due to one car assuming, at the instant of collision, a higher or lower

horizontal plane than its adjoining neighbor, causing one to ride the other with the resultant telescoping effects.

20 It is generally conceded, that in cases of two cars tending to telescope, the point of maximum shock is never over 20 in. above the floor line. In the Government postal car specifications, this point has been definitely fixed at 18 in. above the floor line, and with this in view the end posts are reinforced for a distance of about 4 ft. above the floor line by steel angles riveted to the Z-bar end posts.

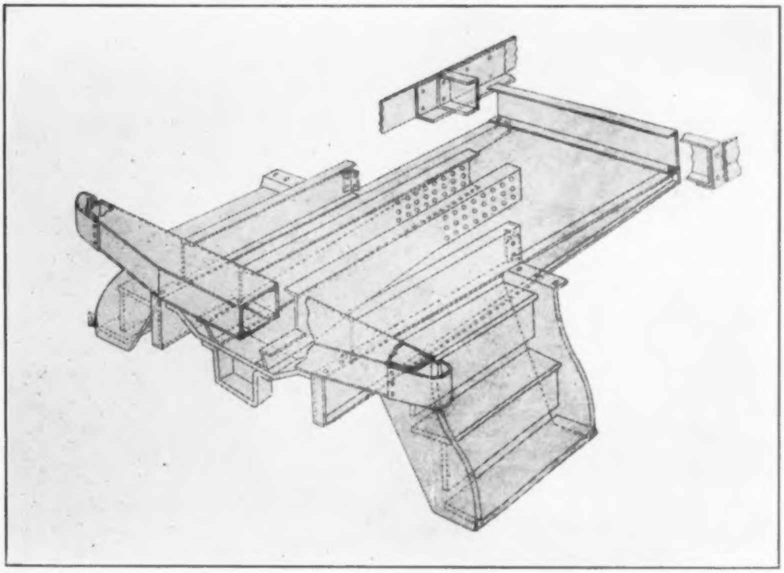

Fig. 15 Skeleton of Platform Members for All-Steel Construction

21 A general idea of this collapsible vestibule is afforded by Figs. 13 and 14. Fig. 13 shows the construction entirely of steel, while Fig. 14 shows a series of wooden posts and platform and vestibule members in addition to the steel members to secure the recognized advantage of the elastic and cushioning properties of the wood.

22 In this construction the longitudinal sills and floor members are designed to stop at the end sill of the car body proper, the end of which is sheathed with a heavy steel plate extending in one piece vertically from the roof downward to the bottom of the end sill. If the shock of collision is not entirely absorbed by the vestibule members before the end of the car body proper

can be crushed, this plate will tend to pull the roof downward and cause the direction of the oncoming car to deflect obliquely upwards instead of the two cars telescoping. Further to offset the effect, should the two cars change their horizontal planes in collision, pressed steel shapes in the nature of anti-climbers, are placed below the buffer beam and platform.

23 Fig. 15 shows the skeleton of the platform members for the all-steel construction, and Fig. 16 shows the skeleton of the platform members where wooden features are employed.

24 The vestibule diaphragm posts are constructed of heavy

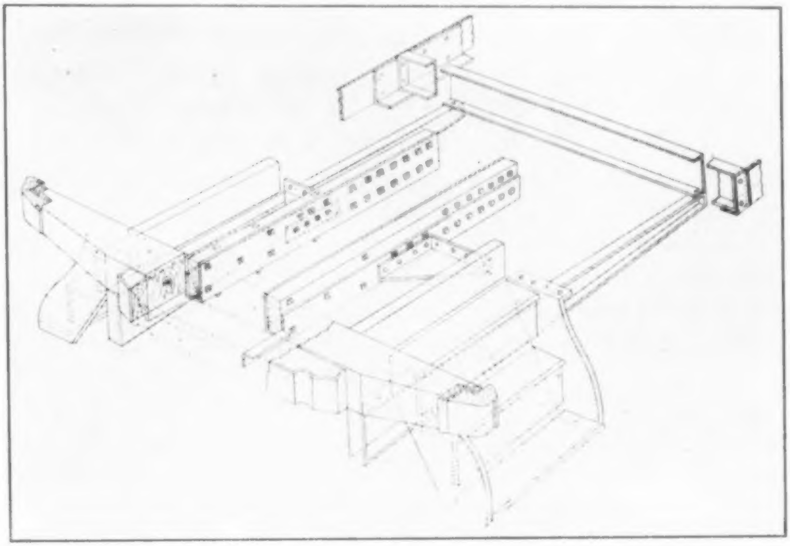

Fig. 16 Skeleton of Platform Members, Steel and Wood Construction

steel I-beams rigidly secured at the bottom to the buffer beam and at the top to the vestibule end plate and longitudinal braces.

25 The platform, vestibule and hood members are designed with a view to withstanding all shocks incident to regular service, but in abnormal shocks, such as would result from collision, the rivets connecting the various members would shear off with the exertion of less energy than would be required to crush the end of the car body, thereby causing the vestibule to collapse, absorbing the shock and furnishing a cushion between the two car bodies proper. It is assumed that in case of a collision these

would be the only parts seriously damaged, and the car could be repaired and replaced in service with a minimum of expense and delay.

26 The entire collapsible vestibule, comprising the platform, vestibule and hood, is constructed as a unit, detachable and separate from the car body proper and can be applied after the car is built or in the alteration of cars already built and is equally applicable to cars of either steel or wood construction.

27 The object of the collapsible vestibule is, first, to protect the lives of the passengers and secondly to protect the body proper of the car from serious damage.

INDUSTRIAL MANAGEMENT

At the Annual Meeting of the Society in December the Sub-Committee on Administration presented for discussion majority and minority reports reviewing the present state of the art of industrial management. These reports were printed in the November Journal; the discussion followed in March. Herewith is published additional discussion together with the closure.

DISCUSSION OF REPORTS OF SUB-COMMITTEE ON ADMINISTRATION ON THE PRESENT STATE OF THE ART OF INDUSTRIAL MANAGEMENT

Frank B. Gilbreth. The report is especially valuable for the reason that it emphasizes the fact, which has long been realized by those engaged in the work of installing scientific management, that transference of skill is one of the most important features.[1] They do not, however, make sufficiently plain that such skill and the experience which precedes it must be measured and recorded before it can be most efficiently transferred.

A better name for scientific management is "measured functional management." It is not sufficient to call it "labor saving management" for it deals with more than labor and labor saving. It is a way for obtaining methods of least waste. It not only saves useless labor, but it improves labor conditions; improves quality of product; prolongs the period of the worker's productivity; conserves, teaches and transfers skill and experience. The committee have caused the Society and the world to recognize at last the importance of the feature of the transference of skill, but they apparently still lack appreciation of the even greater feature of the recording and transference of experience of Mr. Taylor's measured functional management and of micromotion study. Mr. Taylor's system is best described in his writings entitled A Piece Rate System, Shop Management, and

[1] See Primer of Scientific Management, F. B. Gilbreth, p. 56; Psychology of Management, L. M. Gilbreth, chap. 8; Motion Study, F. B. Gilbreth, p. 36.

The American Society of Mechanical Engineers, 29 West 39th Street, New York. All discussion is subject to revision.

On the Art of Cutting Metals, published by the Society, and Principles of Scientific Management, published by Harper & Bros.

As brought out in the report, the importance of transference of skill was realized many years ago. Studies in division of work and in elapsed time of doing work were made by Adam Smith, Charles Babbage, M. Coulcomb and others, but accurate measurement in management became possible when Mr. Taylor devised his method of observing and recording elementary unit net times for performance with measured allowance for fatigue.

It is now possible to capture, record and transfer not only skill and experience of the best worker, but also the most desirable elements in the methods of all workers. To do this, scientific management carefully proceeds to isolate, analyze, measure, synthesize and standardize least wasteful elementary units of methods. This it does by motion study, time study and micro-motion study which are valuable aids to sort and retain all useful elements of best methods and to evolve from these a method worthy to be established as a standard and to be transferred and taught. Through this process is made possible the community conservation of measured details of experience which has revolutionized every industry that has availed itself of it.

Micro-motion study, presented for the first time at this meeting, is a new and accurate method of recording and transmitting skill. Based upon the principles of motion study and time study, it makes possible simultaneous measurement of both time and path of motions. It produces an entirely different result from any of the methods attempted by its predecessors, in that it shows a measured difference in the time of day on each and every cinematograph picture, even when the pictures are taken at a rate much faster than ever considered in work where positive films are printed and projected upon the screen.

The devices used in making micro-motion study are adaptable to the needs of the work. The kind of clock and camera used and the number of pictures taken per unit of time depends upon the nature of the work observed. For those interested primarily in the time study work of a machine shop, the clock that shows divisions of 1/200 of a minute is recommended; for ordinary problems of motion study, the clock showing divisions of 1/1000 of a minute is the best; and for those who desire to make the finest of motion and time studies for the purpose of obtaining ultimate methods of least waste, the clock showing divisions

of $\frac{1}{1,000,000}$ of an hour or less is absolutely necessary. Such a clock is essential for discovering the method of least waste in cases such as handing instruments to a surgeon when operating. There is no case in the industries where the necessity for highest possible speed consistent with desired results is so great. For example, when operating for mastoiditis, it is necessary that the probe to lift the scalp be used within the shortest possible time after the skin has been cut, before the blood has had time to run down into the cut. Micro-motion study and stereo-cycle graphs are the only methods that will measure the times and paths of different motion methods for doing this portion of the operation. Micro-motion study has already determined that the combining of two or more instruments or tools for such cases and reversing the ends in the hand is much quicker than dropping one tool and grasping another.

Not only is it possible with micro-motion study to make more accurate measurements of shorter times than one could with any other method of motion or time study, it is also less expensive, even for ordinary work, than the older stop-watch method. Much of the work can be done by a less skilful man than the old-time study man; moreover, provision is made for stopping all photographic expense during any time the worker is resting, or doing work where no record except elapsed time is wanted.

Recent improvements in the method of taking pictures and of using half-width films, with nearly twice as many pictures to the foot and about one-third as many to the second as is used in motion pictures of the standard "movies," have still further reduced the cost of taking micro-motion studies.

Because of the flexibility of the micro-motion study apparatus the possibilities of its use are much extended. It is possible to take pictures as slowly as is desired, for such observations for example, as are required on time study of the machine's time, such as one picture per minute, while when it is desired to study the minutia of motions the pictures can be recorded at any desired speed, even at the rate of 1,000,000 per hour, for short periods. Recording as it does rest periods as well as work periods, micro-motion study presents complete as well as accurate records of the skill displayed.

These records are not only indispensable to those who are to teach or transfer the skill or experience, are in themselves use-

ful as object lessons, but more important than all else they are the devices that measure and record the skill which is to be transferred. They are used by the man who makes standards to determine the most efficient method of doing work. By them he is able to "take any motion apart" and to think in elementary motions. Being provided not only with a record of the best method of the best man, but with records of the best methods of all most skilled workers, he can synthesize these into a standard method which will be better than any of the methods submitted, and is likely to be better than all combined.

To the worker this knowledge comes in various ways: He may be given photographic films depicting some method that he desires to acquire. These he can study at his leisure; making the demonstrator do the work as slowly as he pleases. The difficulty that most skilled workers find in making habitual motions slowly is a great hindrance to learning by observing them. The film records the swiftest motions, which can be taken apart and observed slowly. He may be given films on which are recorded methods of distant shops whose workers he would never otherwise observe. The worker may be taught not directly by the films, but by methods derived indirectly by them.

With records of skill that fulfil the three requirements of measurement, namely, (*a*) of proper units (*b*) made by scientifically derived methods (*c*) with devices that reduce expense, and with transference of skill that assures every worker an opportunity to acquire the best that has been thought and done in his line, scientific management can now look forward to fulfilling the ultimate demands, justify itself from the economic viewpoint, and reduce the cost of the product to the consumer.

Closure. The large amount of discussion offered on the report on The Present State of the Art of Industrial Management shows the interest in this subject on the part of members of the Society. This, and the manner in which the report was received, are sources of gratification to the committee. Although a few points were singled out for objection, the report as a whole seems to have been approved. In fact, these objections as they appear in the printed discussion, in most cases can be directly offset by quotations from the same source.

The first objection is that the report gives "no more than a fragmentary idea of the conditions under which this art is carried on in the United States today," first paragraph of Mr. Go-

ing's discussion. Offsetting this, we quote from the first paragraph of Mr. Gantt's discussion, "The committee have caught fully the present spirit of the movement now in progress, and Pars. 45 to 58 of their report seems to me to be an excellent resumé of the subject." It was obviously improper for the committee to consider the details of the systems of the art of management as practised, but it was essential to show the spirit of the movement and if possible the principles upon which it rests. This the report endeavored to do, and did do in the opinion of the member quoted above.

Mr. Thompson pointed out that there are several criticisms made by workmen against modern industrial management, and that labor unions are busily fighting its introduction. With further reference to these features is this sentence, "The report of such a committee as this should not have overlooked the opportunity to begin or extend the campaign of education in these particulars." And again, in regard to the dehumanizing effect on the workers of the methods of modern industrial management the same author says, "This committee must have had an opportunity to look into this side of the case; and it is to be regretted that they have not improved it more fully."

This author seems to have overlooked the necessity which compelled the committee to treat of their subject in a non-controversial manner. At the same time, the broad results from industrial management are clearly stated in Pars. 62 and 63. These seem sufficient to meet this criticism. In regard to the statement that the criticism of the dehumanizing effect should have been met, we need but quote from Mr. Coburn's discussion to show that the human side of the subject was found by one of the Society's members, "—the committee have expressed in their report the human interest side of scientific or labor-saving management, which some of its critics say it lacks." Further, the entire discussion of H. L. Gantt develops the point that the workers are benefited by the best of modern management.

The term, transference of skill, is used frequently in the report and conveys one of the important ideas in the definition of the new element in the art of management. This term seems to have been misinterpreted, for near the end of Mr. Thompson's discussion we read, "In this report the committee emphasize the 'transference of skill' as the basic feature of the new labor-saving management. Unfortunately, however, it appears that

this term is used with two meanings. Throughout most of the report it seems to mean the accumulation of skill by the planning department and its transference from this department by actual instruction to the workmen just as machinery is said to be the transference of skill, according to the report, from the designer and draftsmen to the machine. The idea intended to be conveyed is undoubtedly right, but the illustration chosen is unfortunate;" and in Mr. Vaughan's discussion, "the transference of skill referred to in the report means in one place, doing away with skill, in another the improvement of skill, and develops into the idea of telling men how to do everything."

The idea of the "transference of skill" is abstract, and these quotations indicate that their authors have failed to get the meaning of the term as used by the committee. "Transference of skill" is a process, and the expression might be expanded into "the process of transferring skill." It was the completion of this process that did away with hand looms and hand weaving in England. At the time of this completion, the skill in hand weaving was the personal possession of the last generation of hand weavers. Men of the succeeding generation did not acquire this skill for there was no economic advantage in so doing. Yet cloth was woven in greater quantities than before, leading at once to the question, where then was the skill? It is evident that the yarn was being manipulated by machines, thus, the former human skill was now in the metal fingers and arms and levers of the mechanism. But a new form of human skill was being developed as the process advanced; this is, the practical ability to tend the machine, keep it in order and producing to its maximum capacity.

The report pointed out that this process had advanced to a great length in the field of machine design, but had remained almost without application in the field of manufacturing. The best of modern industrial management applies this process to all of the activities of manufacturing, that is, a study is made of the steps of manufacturing in the same way that a study is made of the steps of designing. The results of handling and operation study are recorded for the instruction of the men engaged in manufacturing, in the same manner that the conclusions of the study of design are recorded on drawings as instructions for what is to be made. The parallel is exact.

It must be emphasized that this process applies to much more

than the operation of machines, it applies to everything that is done in handling materials, machines, tools, and labor used in production. It is unnecessary to list these in detail, for everyone acquainted with manufacturing appreciates what is included. The training of the workmen is but one small, though important, part of the application of this process of transferring skill.

Regarding the discussion as a whole, there are two striking characteristics that attract and hold attention; the entire absence of exaggerated statement and the presence throughout of a humane spirit in keeping with the best trend of thought toward social justice. The first of these, the absence of exaggeration as to what industrial management has done or can do was to be expected in any discussion before a body of engineers. The second shows clearly the development that has taken place within the last few years leading to a new appreciation of the needs and rights of employees.

But this commendable attitude of justice does not seem to have had its full influence on the relations existing between management experts. Among some of these, there is an unfortunate spirit of intolerance. This is in marked contrast to the spirit prevailing in all the great divisions of engineering. In these there is room for the cadet engineer as well as the recognized expert and for many others between these two extremes possessing varied degrees of knowledge and experience, as witness the membership of our own Society. The same is true in the field of industrial management. There is room and need for everyone who understands the principles upon which it rests and who will conscientiously and intelligently apply them.

This situation and these facts should lead to a tolerant attitude between all who are honestly trying to further the art of industrial management, and there should exist the same spirit of mutual helpfulness and encouragement which actuates those in other lines of engineering specialization. On the other hand, all who are trying to exploit the present interest in this important subject for mere personal advantage must be unsparingly condemned.

J. M. Dodge, *Chairman* L. P. Alford, *Secretary* D. M. Bates H. A. Evans W. L. Lyall W. B. Tardy H. R. Towne	*Members Sub-Committee on Administration*

FOREIGN REVIEW

BRIEF ABSTRACTS OF CURRENT ARTICLES IN FOREIGN PERIODICALS

CONTENTS

The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Review. Articles are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of exceptional merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

FOREIGN REVIEW

Attention is called to the table of equivalents for compound units. It is intended exclusively as a help to readers of foreign periodicals, and is considerably more complete than similar tables in the usual reference books.

THIS MONTH'S ARTICLES

Karpen's article on the planing flight of birds and Sée's on a new principle of longitudinal stability both contribute valuable new material to the still very young science of aeromechanics, the Sée principle of stabilization being of particular interest in that it may be immediately turned to practical purposes. In the new section, Farm Machinery, two types of power plows are described, a French and a German, with data as to cost of operation. The French type is interesting as an indication of the tendency to apply soil cultivation by mechanical power to small estates. An abstract in the section Internal-Combustion Engineering gives data on the cost of operating gasolene locomotives in mines in Belgium, as well as a brief discussion of the application of Diesel engines to driving locomotives, directly or with an electric power conversion. Neumann's article on thermal processes in a gas producer is of interest as it claims to be the first attempt to investigate the gas producer by determining the direction of thermal changes in it as a system subject to external influences. Hanffstengel, in the preliminary publication of his experiments on the power consumption of hoisting apparatus, discusses the bending resistance and breaking strength of chains, bending resistance of belts, scraper and conveyor worm efficiency, etc., which makes a welcome addition to the far from rich fund of the experimental data on hoisting machinery. Additional data on belts, by Kammerer, may also be mentioned in this connection. Particular attention is called to Leblanc's description

of automatic balancers, in view of the apparatus described as well as of the author's exposition of the theory of bodies rotating at high speeds. In the section Steam Engineering data may be found on the cost of permutit water purification. In the same section an abstract from an Italian periodical gives a detail discussion on the influence of cold air leaks on the efficiency of economizers, as well as a discussion of the Oddie-Simplex steam-air pump and Simplex valve gear. Attention of steam engineers is also directed to Daiber's article, in the next section, on stresses due to bending in lap riveted boiler seams indicating how such stresses can be determined graphically. A simple and efficient method for fireproof storage of drawings is described in the last section, Miscellanea, where may also be found data on melters' fever, production of moving pictures in factories, etc.; a brief discussion of scientific management and objections made to it by German labor papers closes the abstracts.

Aeronautics

On "Planing" Flight of Birds (*Sur le vol des oiseaux dit "vol à voile,"* V. Karpen. *Comptes rendus des séances de l'Académie des Sciences*, vol. 156, no. 10, p. 762, March 10, 1913. 2 pp. *t*). Investigation of conditions permitting planing flight of birds. The weight of the bird P in kg and the surface of wings S in qm are connected by the equation: $4\ S = P$. It is shown further, that in order to plane, the bird has to flow into the wind when the velocity of the latter decreases, and against the wind when it increases, and in order that the bird may maintain itself in the air without either descending or ascending, the velocity of the wind must *increase or decrease* at the rate of at least 0.30 m (0.98 ft.) per sec., if the direction of the wind is horizontal. If the wind has a vertical upward component, it tends to decrease the necessary minimum of the horizontal acceleration or deceleration. Generally, planing is possible whenever the average of geometric acceleration or deceleration is from 30 to 50 cm (0.98 to 1.6 ft.) per sec.

A New Principle of Longitudinal Stability of Aeroplanes (*Sur un nouveau principe de stabilité longitudinale des aéroplanes*, A. Sée. *Comptes rendus des séances de l'Académie des Sciences*, vol. 156, no. 8, p. 613, February 24, 1913. 2 pp. 1 fig. *et*). The usual principle of longitudinal stabilization is the so-called principle of longitudinal V, or the distribution of two fixed surfaces one behind the other, in a manner such that the front surface has a greater angle of incidence than the rear one (cp. *The Journal*, February 1913, p. 321). Instead of this, the author proposes the application of an entirely new principle, illustrated in Fig. 1. Let the aeroplane be composed of the main supporting plane A located behind the

plane *B*, the latter being free to rotate about the transversal axis *C*, and convex bottomwards, or generally of a shape such that the pressure of the air against it increases when the incidence decreases (there are S-shaped planes having this property as well as good supporting qualities). In motion, the plane *B* automatically takes a position such that the air pressure is taken up by the axis *C*, and the plane maintains a constant incidence. This is shown by Fig. 1. When the apparatus is in equilibrium, the two pressures *D* and *E* on the planes *A* and *B* have the resultant *R* passing through the center of gravity. If the apparatus dips forward, the angle of incidence of the two planes is decreased; the pressure *D* on plane *A* decreases, but the plane *B* immediately resumes its former incidence, and consequently the pressure *E* does not vary. The resultant of *E* and *D* therefore approaches *E*, and produces a couple which tends to relieve the bow of the apparatus, or to restore the original position. The same happens when the apparatus dips aft. The stabilizing action is greater than when the principle of longitudinal *V* is applied. To verify it experimentally, the author constructed a model of reduced dimensions which fully confirmed the theoretical expectations.

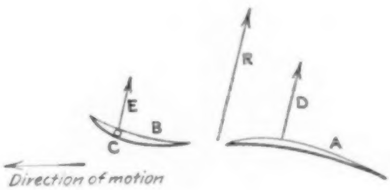

FIG. 1 SECOND SÉE PRINCIPLE OF LONGITUDINAL STABILIZATION OF AEROPLANES

Air Machinery

COMPRESSED AIR METERS AND DETERMINATION OF AIR CONSUMPTION (*Les compteurs d'air comprimé et l'évaluation de la consommation d'air*, W. Glucksmann. *Annales de l'association des ingénieurs sortis des écoles spéciales de Gand*, ser. 5, vol. 5, no. 4, 1912. 12 pp., 12 figs. *d*). General discussion of compressed air metering and description of the Hodgson compressed air meters. The article is based on the practice in South Africa where, in the mine fields, compressed air is produced in central stations and sold to subscribers like gas and electricity, necessitating reliable automatic meters.

MODERN STEEL PLANT GAS BLOWERS (*Neuere Stahlwerks-Gasgebläse*. Schomburg. *Die Fördertechnik*, vol. 6, no. 2, p. 38, February 1913. 2 pp. *as*). A general comparison of steam and gas blowers for steel plants, with tables showing the dimensions of the blowers of both kinds now in use, and lately ordered mainly for German plants, as well as the blower equipment of a large German steel plant. The gas blower shows an economy of 20 to 50 Pf. per ton (4.6 to 11.4 cents per short ton) raw steel.

For reserve power the older mills keep their steam engines, while more modern plants use either reciprocating or, more often, turbine steam drive. In one plant a tandem gas engine is used to supply the blast both to the blast furnaces and the steel making plant, thus providing for reserve power.

Farm Machinery

LATEST MOTOR PLOWS (*Neuere Motorpfluge*, K. Praetorius. *Zeits. des mitteleuropäischen Motorwagen-Vereins*, vol. 12, no. 5, p. 107, Mid-March 1913, 6 pp., 15 figs. *d.* The article is to be continued). Description of some of the latest types of German motor plows. Fig. 2 shows the plow of the

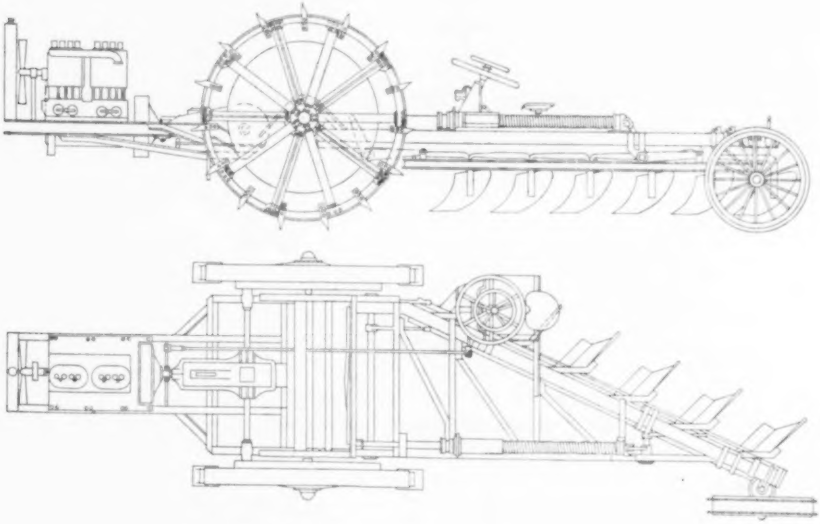

FIG. 2 MOTOR PLOW OF THE GERMAN POWER PLOW COMPANY

German Power Plow Co. (Deutsche Kraftpflug-Gesellschaft m.b.H.). It is a three-wheel type, with the two front wheels as drive wheels. The power transmission from the motor to the axle is by means of cone clutch over the differential gear. The plow frame is movably suspended on bell crank levers in a manner such that by rotating the screw spindle shown in Fig. 2, these bell crank levers can be displaced and thereby bring the plow frame to the ground either parallel or at a desired angle. This can be done from the driver's seat so that when an obstacle is encountered, the driver does not have to get up; at the same time, by means of a special spring arrangement, the frame is so balanced that the winding up of the screw spindle can be done without great exertion. The spikes on the wheel circumference have three vertical adjustments to suit various ground

conditions, and are of a shape such as easily to penetrate into the ground. By coming out in a nearly vertical direction, the amount of earth and clay adhering to them is minimum. The steering wheel is provided with sharp spikes, to find the necessary purchase in plowed over ground. When traveling along highways, a cover bandage is slipped over the wheels to pro-

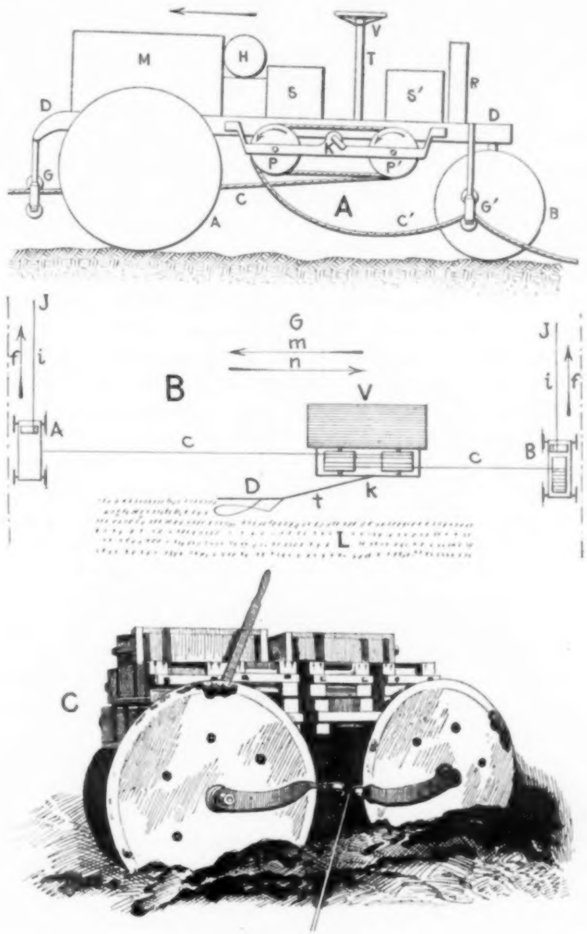

FIG. 3 ARION TOWING TRACTOR

tect the spikes. The plow is driven by a 50-h.p. internal-combustion engine, and the operation cost per day, at the rate of 100 working days per year, plowing to a depth of 25 cm (say 10 in.) 20 Morgen (12.6 acres) per day, is at M.3.72 per Morgen ($1.43 per acre). No detailed cost data are given.

TOWING TRACTOR ARION (*Le tracteur-toueur Arion*, Fernand de Condé. *Bulletin de la Société d'Encouragement pour l'industrie nationale*, vol. 119,

no. 1, p. 159. January 1913. 5 pp., 5 figs. *d*). The principle of the Arion tractor is the same as that of a towing boat. The tractor proper consists of a four-wheel carriage with a 30 to 40-h.p. explosion engine running at the normal speed of 450 r.p.m. On the side of the car body are two pulleys *P* and *P'* (Fig. 3 A), each with four grooves and means for connecting it with the engine. The plant (Fig. 3 B) is installed as follows: A stationary cable *c*, 15 mm (say 0.6 in.) in diameter, is stretched across the field between two anchors *A* and *B*, and coiled up on the pulleys *P* and *P'*; when these pulleys are set in rotation by the engine, they coil up the cable, and drive the vehicle towards, say, the point *B*, and the vehicle drags a plow or other implement after it. When the tractor reaches *B*, it is reversed, and goes back to *A*. The big wheels of the tractors are the running wheels, the small ones the driving wheels; the two-wheel trains run in different tracks, which permits the driving part of the cable *c* to pass between the big wheels, and *c'* to pass outside of the track of the small wheels, thus letting the cable run without interfering with the action of the wheels. Since the carriage moves first in one direction, and then in another, along parallel lines, it is provided with two seats for the driver *S* and *S'*, that he may face in the direction of motion; in order that he may always make the same motions for guiding the machine, the flywheel *V* and controlling rod of steering gear *T* are arranged so that they can engage with the driving chain either directly (one way) or by means of gears (when going the other way). The apparatus has no change speed gear; the flexibility of the engine which can run from 350 to 700 r.p.m. takes care of that. In addition to that, the speed of the displacement of the tractor may be varied by using different pulleys, say 30, 40, and 50 cm. (11.8, 15.7, and 19.6 in.) in diameter. Laterally the traction is effected by means of the chain *t* (Fig. 3 B). The tractor proper is of simple construction, and weighs only about 1500 kg, or about 3300 lb., practically the weight of two strong oxen.

There is however an important addition to it, viz., the anchor-cars (Fig. C); their frame is carried on four small wheels, with axles parallel to the direction of plowing. The two wheels on the side towards which the cable is stressed, are provided with sheet-iron discs of a diameter larger than the wheels, held against the spokes by bolts in a manner such as to form a spherical cap; this disc penetrates into the ground and, owing to its concave form, the tension of the cable tends to drive it deeper; to prevent the anchor-car from tilting sidewise, it is loaded with stones or pieces of iron, and the cable is attached as near the level of the ground as possible. At each operation the anchors have to be displaced in the direction of the shaft *f* (Fig. 3 B), a distance equal to the width of the furrow. The article indicates how this is done. Two men are required to operate the tractor, an engineer, and a man to take care of the anchors; two men, one at each of the anchors, are said to give still better results. Some data of tests are cited in the article.

Internal-Combustion Engineering

Two Years of Practice with Gasolene Locomotives (*Deux années de pratique avec locomotives à benzine*, A. Baijot. *Annales de mines de*

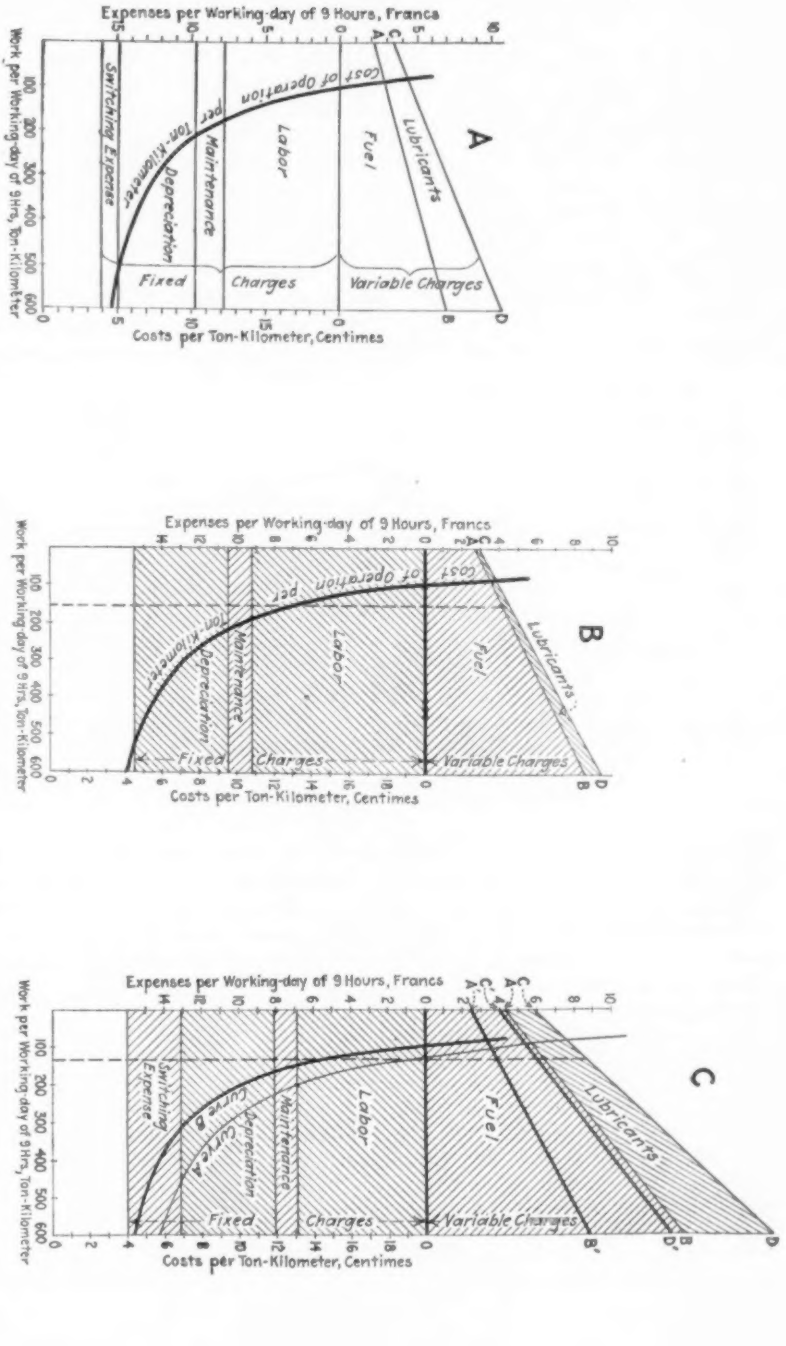

Fig. 4 Gasolene Mine Locomotive Operating Costs in Belgium

Belgique, vol. 18, no. 1, 1913, p. 3, 43 pp., 17 figs. *dp*). Data on Belgian practice of *gasolene mine locomotives*, of which the most important are presented in Fig. 4, 1 franc = \$0.193; 1 franc per ton-kilometer = \$0.282 per short ton-mile. The following conclusions can be drawn from these curves, at least as far as the Belgian practice is concerned: The fixed charges are the same nearly everywhere, and depend on the rate of wages, with a material increase in mines where switchmen are required; the variable charges are primarily functions of the cost of gasolene, the consumption being practically uniform in all cases. On the other hand, the consumption of oil and grease appears to vary considerably from plant to plant. In a general manner (Fig. 4 C) the curve of prices will be at *B* with price of gasolene at 18 frs. per 100 kg., but shifts to *A* when the price of gasolene rises to 32 frs. The most important fact which these curves show, however, is that the locomotives must be worked as hard as possible; with 400 to 500 ton-kilometers (275 to 340 ton-miles) in a 9-hour

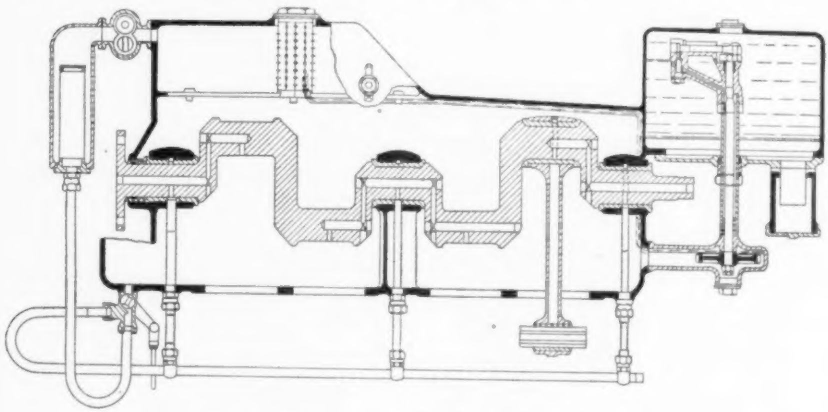

FIG. 5 NECKARSULMER CAR LUBRICATING SYSTEM

working day, the price per ton-kilometer is 5 to 7 centimes (\$0.013 to 0.018 per short ton-mile); often, however, only about 250 ton-kilometers per working day are made, in which case the cost rises to 8 to 11 centimes per ton-kilometer, and it goes up still higher when the work done per locomotive per day falls lower. On the whole gasolene locomotives in Belgium proved to be both economical and efficient, except in particular places where conditions are unusually unfavorable.

CAUSES AND EFFECTS OF PREMATURE IGNITION IN EXPLOSION AND COMBUSTION ENGINES (*Causes et effets des allumages prématures dans les moteurs à explosion et à combustion. La Revue électrique*, vol. 19, no. 222, p. 270, March 21, 1913. 1½ pp. *p*). From a paper read by L. Letombe at a meeting of the Société des Ingénieurs Civil de France on February 7, 1913. General discussion of the causes of premature ignition. For a detailed abstract see *The Automobile*, April 10, 1913, p. 805.

DIESEL ENGINES AS MOTIVE PLANT FOR RAILWAY LOCOMOTIVES (*Dieselmotoren als Triebmaschinen für Eisenbahnfahrzeuge, Elektrische Kraft-*

betriebe und Bahnen, vol. 11, no. 4, p. 84, February 4, 1913. 1½ pp., 2 figs. *cd*). The advantages of the Diesel driven locomotive are: better use of fuel permitting an economy of 40 per cent against coal, even though the fuel itself costs nearly 240 per cent as much as coal; possibility of longer runs, and lighter fuel load on the engine. The direct-drive Diesel locomotive of Sulzer Bros. (for preliminary data of its construction cp. *The Journal*, June 1912, p. 942), according to the article, does not appear to have proved a success, mainly because direct-drive is little suitable for locomotive work. A large torque has to be exercised at the start at slow speed, and this calls for dimensions larger than would otherwise be necessary. On the other hand, Diesel electric locomotives are said to have been more efficient, since the engine can be driven at a high speed (direct-connected with the generator and exciter) and work at constant load. The article contains some brief data on the Diesel electric locomotive built for experimental and demonstration purposes by the Swedish General Electric Company in Västeras and operated on the Swedish State Railroads.

German Automobile Constructions (*Deutsche Automobil-Konstruktionen*, P. Fielehr. *Auto-Technik*, no. 6, p, 31, appended to *Allgemeine Automobil-Zeitung*, vol. 14, no. 11, March 14, 1913, serial, not complete. *d*). Description of some of the latest types of German automobiles. Fig. 5 shows the double lubricating system of the car of the Neckarsulmer Fahrzeugwerke A-G. In addition to the usual geared pump which provides lubrication for the bearings of the crankshaft, connecting-rod and piston pin, there is also a plunger pump which supplies oil to the crank case as it is used up in the engine. This second pump is placed inside an oil tank of proportions such as to provide oil for a run of 350 km (say 217 miles), and is driven from the camshaft by a worm and wormwheel. It has only one valve consisting of a ball pressed by a spring against the valve seat. The oil from the tank is sucked in through a hole in the pump casing, and part of it is forced out again until the piston in its downward stroke closes the opening; the oil remaining in the pump is then forced through the pressure valve along the pump shaft into the crank case, where it mixes with oil of circulation and is further taken care of by the geared pump. As shown in Fig. 5 it is impossible to shut off entirely the admission of the lubricant to the bearings, which therefore cannot run dry, even with careless operators; excessive lubrication may, however, be easily regulated.

The Processes in a Gas Producer from the Standpoint of the Second Law of Thermodynamics (*Die Vorgänge im Gasgenerator auf Grunde des zweiten Hauptsatzes der Thermodynamik*, Kurt Neumann. *Zeits. des Vereines deutscher Ingenieure*, vol. 57, no. 8 and 9, pp. 291 and 338, February 22 and March 1, 1913. 12 pp., 21 figs. *ctA*). An attempt to investigate the processes in a gas producer not on the usual principle of conservation of energy, but in accordance with the second law of thermodynamics, by determining the direction of changes in a system subject to external influences. The author claims that although several investigators have established the fact that the interaction between air and steam on one hand, and glowing coal on the other, leads, at certain temperatures, to

chemical equilibria, it is still an open question how near an approach to these equilibria is made in actual practice, and what are the most favorable conditions leading to the production of a gas of given composition. This is a complicated problem, because to determine gas reactions in a heterogeneous medium, measurements of pressure and temperature, as well as knowledge of the components of the gas phase, are required; in addition, the functional connection between the gas flow and time necessitates making these determinations in various layers of the producer and at several different points of each layer. Only the main deductions of the article can be given here. The author found that inside the coal column the water gas reaction, and in free gas space the carbon monoxide-carbon dioxide equilibrium are of fundamental importance. In the fuel bed the gas reactions are accelerated by the glowing coal, providing conditions in which the state of mutual equilibrium between the gases is easily established. In the free gas space there occurs a displacement of the gas phase until the velocity of reaction is reduced to such an extent that the gas acquires a composition corresponding to the given temperature. The equilibria limiting the chemical reactions in the gas producer are functions not only of pressures and temperatures, as would appear from the thermodynamic equations, but also, and to an essential extent, of time and constitution of the surface dividing the solid from the gaseous phase. This explains the variations in the composition of gas even in producers working under approximately similar conditions. Since in practical gas production operation the value of *all* the factors influencing the operation cannot always be fully determined, it becomes the more important to make a correct selection of at least those which can be so determined, and it is to be regretted that there is up to now no simple way of quantitatively regulating the composition of the gas in accordance with the amount of steam and air supplied. The loss of chemical energy in the final gas can be reduced by raising the gas velocity, that is, by a greater load on the producer; this method is however only partly efficient, since, with higher output, the temperatures in the fuel bed rise, and with them the velocity of reaction of the passage of gas through the dividing surface. On the other hand, by an application of a constantly cooled pipe, the time for cooling the gas may be reduced so as to permit a practically infinite velocity of gas flow, and reduce the loss to nearly zero. The loss can only be reduced, however, by endothermal reactions, and cannot be eliminated entirely.

Hoisting Apparatus

EXPERIMENTS ON THE POWER CONSUMPTION OF HOISTING APPARATUS (*Versuche über den Kraftverbrauch von Fördermitteln*, G. von Hanffstengel. *Zeits. des Vereines deutscher Ingenieure*, vol. 57, no. 12, p. 445, March 22, 1913, 9 pp., 29 figs. *eA*). Experiments to determine the power consumption of hoisting machinery, conditions influencing its magnitude, and methods for determining it, the last of particular importance, in the author's estimation, since it is of the greatest value to the practical engineer to be shown by what conditions the power consumption of hoisting machinery is affected; how to approximately determine the power consumption in usual

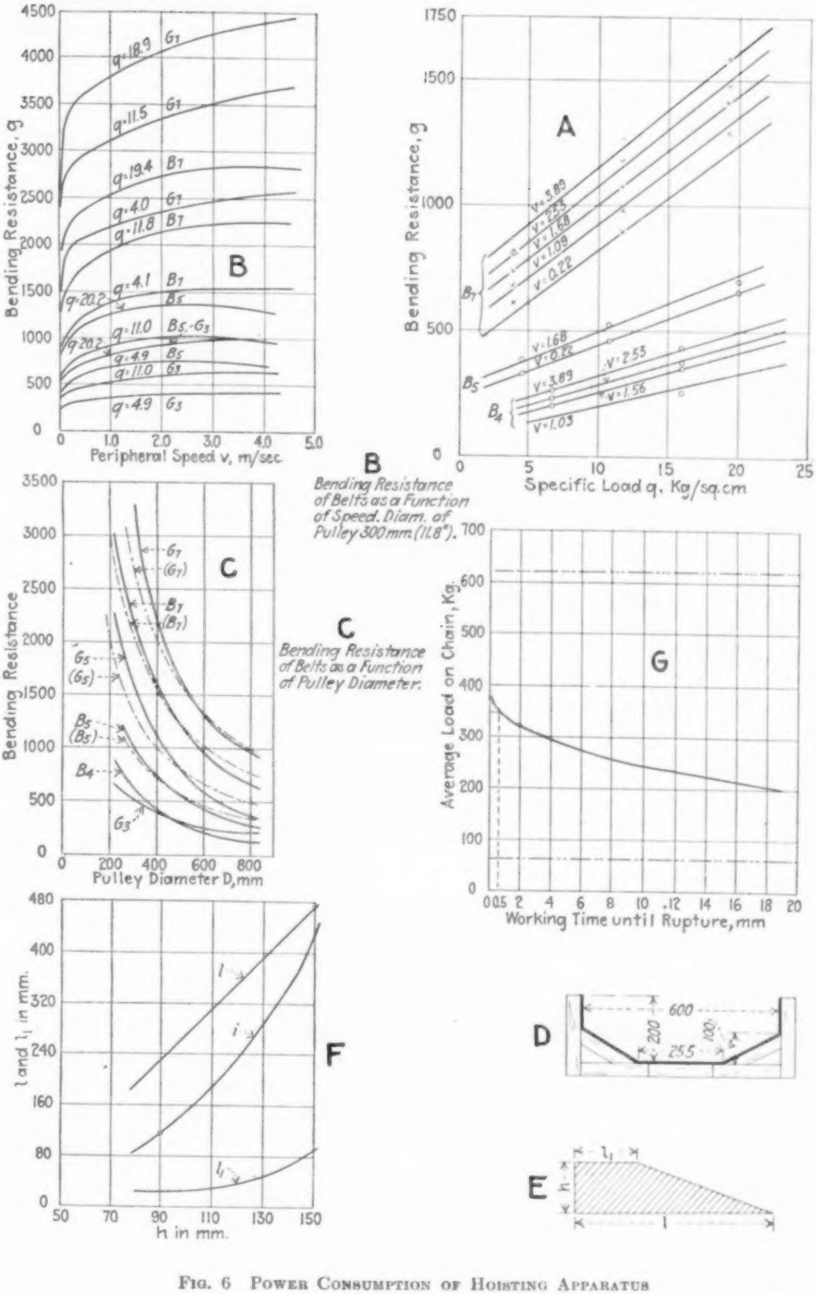

FIG. 6 POWER CONSUMPTION OF HOISTING APPARATUS

cases, and how to go about obtaining the required data for the design of the more or less usual types. The several types and elements of hoisting machinery required all special tests to determine their influence on the power consumption; owing to lack of space, only the main data of this interesting investigation can be reproduced here.

Bending resistance of belts was measured for low velocities by placing the belt over a pulley the axis of which was free to roll on a smooth path; at both ends of the belt weights were placed, and the difference in the weights which started the motion of the pulley gave the bending resistance of the belt. A different arrangement, involving the use of two pulleys, was employed for higher speeds. Fig. 6 A shows the bending resistance of a belt 100 mm (3.9 in.) wide, for three balata belts B_4, B_5 and B_7, 5, 6 and 9 mm (0.196, 0.236 and 0.354 in.) thick, referred to specific loads in kg/qcm. In this case, as with nearly all other materials, the curves are straight lines. Fig. 6 B shows the bending resistance as a function of the speed, for the balata belts B_5 and B_7 and for a rubber belt G_5, 5 mm (0.196 in.), and G_7, 9.7 mm (0.38 in.), thick. The resistance increases rapidly at first, then slowly, and, in the case of the B_5 belt, decreases somewhat from a certain point. That the resistance is slight at low velocities can be explained by the assumption that the fibers have time to make room for each other, while at greater speeds the belt acts as a homogeneous body and has to be bent like a unit. As Fig. 6 C shows, with the increase in pulley diameter, the resistance decreases somewhat more rapidly than would be expected from an assumption of proportionality. This is shown in Fig. 6 C where the dotted lines indicate what the curve of bending resistance would have been under the law that resistance is inversely proportional to the diameter of pulley. The author shows also by means of curves the influence of the method of splicing belts on their bending resistance.

Bending resistance of chains. Their bending resistance proper, produced by the friction in the chain joints when running on and off the wheel, is expressed by the formula:

$$W_r = Q\mu\frac{d}{D}$$

where Q is the load on the wheel, or the sum of the tensions in the chain. It has been found however in these tests that μ is smaller for large chains than for small ones, and that the resistance generally increases with time of operation.

Scraper tests. A scraper trough, Fig. 6 D, of the American type was used, 4 m (13.1 ft.) long, covered with sheet iron on the inside. A carriage on wheels was driven over the trough, while a shovel ran through it. The experimental variables were: the material handled, width and cross-section of trough, shape of shovel, velocity of its displacement and degree of filling of the trough. It was found that the specific resistance referred to 1 kg of the material conveyed depended neither on the velocity nor degree of filling, but was materially (up to 10 per cent at least) affected by the shape of the shovel and trough. Inclining the shovel in the direction of motion made the resistance about 7 per cent higher than when the shovel was vertical; the American trough, Fig. 6 D, was found to be the most efficient. Tests were also made to determine the output of a scraping trans-

porter. The material conveyed, in this case coal dust, usually takes the form shown in Fig. 6 E in front of the shovel: the values of l_1 and l for different values of h have been determined, and together with calculated values of the volume of heap i plotted in Fig. 6 F.

Tests of a conveyor worm. It was found that the hardness of the material handled is here of primary importance, due evidently to the fact that the conveyor worm has either to push the stuff ahead, or break it.

The author has also fully investigated the extraction resistance in bucket elevators and the action of this type of apparatus, not reported here owing to lack of space. The following data found during the course of the investigation are of interest:

Coefficient of resistance of iron on smooth rail	0.16
Coefficient of resistance of iron on greased rail	0.12
Rolling friction	$f = 0.024$

Breaking strengths of chains at various speeds of operation. Fig. 6 G shows how long a Stotz driving chain at various loads lasted until ruptured, the speed being 3 m (9.8 ft.) per sec., the diameter of the wheel 500 mm (19.6 in.). For some special cases the author gives, in percentages, data

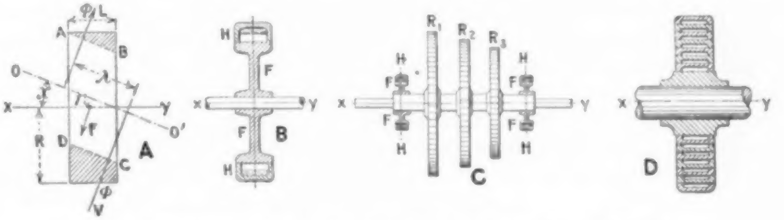

FIG. 7 LEBLANC AUTOMATIC BALANCER FOR HIGH-SPEED ROTORS

on the material destroyed by handling in scraping transporters, bucket and worm conveyors. Full data of this investigation will be published in an early issue of the *Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens.*

Machine Shop

USE OF THE OXY-HYDROGEN FLAME UNDER WATER (*Verwendung der Wasserstoff-Sauerstoffflamme unter Wasser, Zeits für Dampfkessel und Maschinenbetrieb*, vol. 36, no. 12, p. 143, March 21, 1913, 1 p., 2 figs. *d*). Description of an apparatus for cutting and welding metals under water. The flame is maintained under water by means of compressed air and a bell-shaped hollow extension screwed on to the usual oxy-hydrogen burner. No details of construction are given, but it is claimed that the working of the apparatus is fully satisfactory.

Mechanics

AUTOMATIC BALANCERS (*Equilibreues automatiques*, Maurice Leblanc, *La Lumière électrique*, ser. 2, vol. 21, no. 2, p. 35, January 11, 1913, 9 pp., 11 fig. *d*. Abstract of the second part of the article; for abstract of the first part see *The Journal*, March 1913, p. 533, particularly last paragraph on

p. 537). The author proves that possible jumps of a poorly balanced rotor may be counteracted by adding to it a perfectly balanced flywheel of sufficient mass. But with high-speed machinery it would be dangerous to make the flywheel of very large mass, running at very high peripheral speed.

Another solution has therefore to be looked for. Assuming that there is a flywheel, let it consist of a homogeneous disc limited by a cylinder of revolution about the axis xy of radius R on one hand and by two planes normal to this axis and at a distance L from each other (Fig. 7 A). Assume now a cylinder of revolution about the axis OO' through the interior of the flywheel and tangent to it at one of its edges. This cylinder and the flywheel have a solid body common to both and represented in section by the rectangle $ABCD$. This common solid has its center of gravity on the axis OO', and is consequently perfectly balanced about its axis of rotation; it can therefore be taken out without affecting the force F tending to reduce the distance between the axes xy and OO', and at the same time with materially decreasing the straightening-out couple $\Phi\lambda$. If only the first of these two effects is demanded from the flywheel, it can be hollowed out, leaving only the rim, or that portion the section of which is shown in cross-section in Fig. 7 A. The remaining mass μ is small in comparison with the mass M since the eccentricity e and angle α are always small in practice; it is the additional balancing mass. In order that it may produce the desired effect it must be distributed along the interior surface of the flywheel in a certain definite manner; on the inside it is limited by the surface of the level, and had it been a liquid inside of a hollow solid rotating about the axis of the figure xy, it would have become distributed of itself in the required manner under the action of the inertia forces developed by its rotation. The next step is to make it a hollow solid filled with mercury. On a shaft with axis of the figure xy (Fig. 7 B) is placed a small flywheel F provided with a shrunk ring H with a circular passage inside. Enough mercury to cover the exterior surface of the ring during its rotation about an axis other than the axis xy, but not enough to fill the passage up completely, is introduced into the passage through holes which are subsequently securely filled up. The height of the passage must be such that the mercury can never come in contact with the inner cylindrical surface of the ring during a displacement of the real axis of rotation. This represents an *automatic balancer* where the mercury acts as a supplementary *movable balancing mass;* mercury is used because with a small volume its mass may be made very large. Let R be the radius of the cylinder representing the exterior limit of the passage H; L distance between its limiting planes normal to the axis xy; δ density of mercury; g acceleration due to gravity. The shaft carrying the balancer is free to select its own axis of rotation, and if it happens to rotate about an axis passing at a distance ϵ from its axis of figure, the forces acting on the little mass of mercury have the same resultant as if they were acting on a disc full of mercury of radius R and width L. The balancer exerts therefore a force F tending to bring together the axes of the figure and that of rotation, and having for its expression

$$F = \pi R^2 L \frac{\delta}{g} \Omega^2 \epsilon$$

But, while the balancer is able to produce a very large force F, its straightening-out couple is comparatively small, and therefore instead of employing separately a force F and a straightening-out couple for bringing together the axis of the figure xy and the real axis of rotation of the rotor $00'$, two distinct forces F may be applied at the extremities of the axis of the figure xy, as shown, e. g., in Fig. 7 C. The author proceeds to show that the mass of mercury which has to be used is double that of a supplementary mass of a solid required to produce the same balancing, which is certainly very little, considering that the supplementary masses required are always small as compared with the masses of the apparatus to be balanced.

The author proceeds to analyze the case of a rotor which is not perfectly free to select its own axis of rotation, as is most often the case. In this case two groups of forces will act on the axis of the figure of the rotor: (a) forces limiting the displacement of this axis and tending to make it coincide with the axis of the figure of the stator inside of which the rotor revolves, and (b) dampening forces constantly opposing the displacement of points on the axis of the figure of the rotor to which they are applied, their direction being that of the velocity of the respective points, but the sense opposite. The author shows further that the elastic forces tending to make the axis of the figure of the rotor coincide with that of the stator will act in the same manner as the balancers; the dampening forces will tend to diminish the amplitude of the jumps of the rotor, and the distance ϵ will attain its maximum when the dampening forces become equal to zero. The action of the exterior forces will therefore tend to bring the axis of the figure of the rotor as near that of the stator as possible, or in other words, make the running as smooth as possible, but since these exterior forces, with the exception of the dampening forces, have their point of support on the brasses of the shaft, there is no advantage to be gained from making them artificially large.

Practical details of construction of automatic balancers. To reduce the amplitude of vibrations of the shaft of a rotor, the mass of mercury in the balancers must be spread on as large an area as possible, this being done by increasing the width L of the balancer passages (cp. Fig. 7 A). Since

$$m = 2\pi R \frac{\delta}{g} L\epsilon$$

and since further m and R are given, the product $L\epsilon$ is constant, and ϵ cannot be reduced without increasing L. A large area of passages, however, may be more conveniently obtained by superimposing a number of passages over each other as shown in Fig. 7 D, which permits making the balancer very powerful with slight volume and weight. This apparatus, scale $\frac{2}{9}$, if made of nickel steel, can run at 500 r.p.s. It must be remembered, however, that should the shaft get out of the axial position by 1 mm (0.039 in.) the push of the balancer to bring it back would be equal, as the author shows, to 3820 kg (8400 lb.), and with a greater deviation from the axial position, a correspondingly more powerful action. Should an accident happen, such as a rupture of a blade of a compressor, causing a large displacement of the shaft from the axial position, the reaction of the

balancer would be large enough to break the shaft. The only way to obviate that is to limit the action of the balancer apparatus to counteracting only a certain amount of shaft deviation, and this can be accomplished by giving to the tore with mercury a height ϵ corresponding to the maximum deviation of the shaft *when under normal conditions*. However, ϵ cannot be made too small or the annular layer of mercury would become too thin and surface tension phenomena too important, since the mercury would collect into drops and not spread uniformly as it should to bring it into perfect balance.

In the case of turbines with one wheel it is advisable to place the balancers near the rotor wheel, and not at the extremities of the shaft, which permits of counteracting the possible oscillatory movements at their very rise, and enables the speed of the blade wheel to be increased still further. The author discusses further the stability of the system of his balancer and the dampening of the oscillatory movements of the mercury mass, and proves among other things that in his experimental apparatus (cp. Fig. 7 D) which run at 500 r.p.s., the centrifugal force developed by the mercury mass was roughly equal to 34,000 times its weight.

TABLE 1 STRESS RATIOS IN BELTS

Kind of Belt	Mark	Stress Ratio ϵ	
		At Standstill	When Running
Link belt	FG 3	1.8	2 to 5
Link belt	FG 4	1.8	2 to 4
Greased leather	LR 2	1.5	3 to 4
Leather with grease removed	LR 16	2.5	2.3 to 2.4
Double belt	LR 10	1.2	3 to 6
Camel hair	KR 5	2.0	3.5 to 4.5

Geometrical Method Permitting the Establishment in a Simple Manner of Several Important Equations of Mechanics (*Méthode géométrique permettant d'établir simplement plusieurs équations importantes de mécanique*, G. Clauzel. *Revue de mécanique*, vol. 32, no. 2, p. 142, February 28, 1913, 27 pp., 16 figs. *m*). A strictly mathematical investigation, not suitable for abstracting in full. By investigating the properties of the axis of two vectors the author derives what he calls the fundamental equation of the projections of the vectors, and proves that by permutation of the indexes of the terms of these equations, the three equations for all three axes in space may be derived. These results are then generalized, and their application shown to such problem as the derivation of the moment of a vector; of the equations of the motion of a solid rotating around a fixed axis or a fixed point; the position of the central axis and the instantaneous sliding axis. The author uses the ordinary vectorial notation (not quaternions), and comparatively simple methods.

Experiments with Belts of Special Kind (*Versuche mit Riemen besonderer Art*, Kammerer. *Mitteilungen über Forschungsarbeiten auf dem*

Gebiete des Ingenieurwesens, no. 132, 1913, 73 pp., 98 figs. *eA*). Partly abstracted from a preliminary publication in *The Journal*, May 1912, p. 798. The author established in all cases of belt operation an excess of axial pressure, i. e., the axial pressure per unit (1 cm.) width of belt $2k_a$ was always larger than would be expected from the axial pressure $2k_v$ measured with the belt stationary. As seen in Fig. 8, in all cases the excess of pressure rises with the speed of the belt, nearly always in the same ratio, and only in the leather belts LR 11 and 14 the excess of pressure rises more rapidly than the speed. In the double belts LR 11, 12, 14 the excess of pressure, in kg per 1 cm width of belt, proved to be nearly double that of simple belts LR 15-45 and 16. In the case of woven belts KR5, and 65, *BaR* 67 and *BlR* 66 the excess of pressure proved to be variable, especially in the case of the camel-hair belts KR5 and 65. The maximum excess pressure was found with the link belts FG3 and 4.

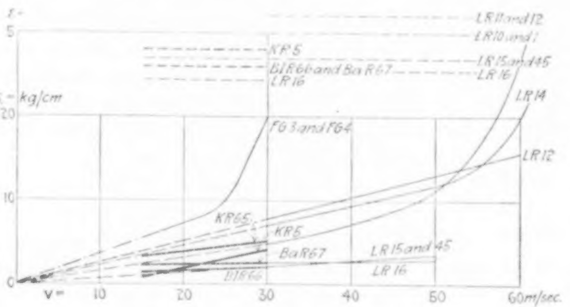

FIG. 8 EXCESS OF PRESSURE AND PRESSURE RATIO CURVES FOR BELTS

The pressure ratio of operation ϵ, or ratio between the stress at the tight and that at the loose side of belt, was found in nearly all cases (exception LR16) to be larger than the pressure ratio ϵ in friction test, the two ratios varying somewhat in different kinds of belts as shown by Table 1. Average values of ϵ are plotted in Fig. 8, which show that where the excess of pressure is high, the pressure ratio value is also high; this points to a probability of there being some connection between the two. The author discusses also the relation between permissible useful stresses and maximum useful stresses.

INVESTIGATION OF THE DYNAMICS OF A THREAD (*L. Roy, Annales de l'École Normale*, Ser. 3, vol. 29, pp. 371 to 429, through *Beiblätter zu den Annalen der Physik*, vol. 37, no. 5, p. 332. *t*). The author applied to the investigation of dynamic phenomena of threads the hydrodynamic theory of discontinuities, particularly discontinuities of the first order, and has thereby obtained general expressions for the propagation of longitudinal and transversal shocks in vibrating strings, as well as treated the problem of an oscillating string with the inclusion of the consideration of its viscosity. In the first chapter the general equations of the motion of strings are established, and conceptions analogous to those applied in hydrodynamics defined and expressed analytically in equations. Equations of continuity,

of motion and temperature are fully gone into. In the second chapter discontinuities are considered kinematically, both those of the first and of the higher orders, as well as their velocity of propagation, discontinuity itself being understood in the sense given to it by Duhem in his *Recherches sur l'hydrodynamique*, 1904. The next two chapters are devoted to a fuller investigation of discontinuities of the first and higher orders, while the last chapter is devoted to a discussion of small movements in threads, mainly near the region of stable equilibrium. It appears that in that case the equations admit of only one solution. Further, the case of a thread is considered as having one end fixed and the other performing a definite motion, and a particular solution was found for this case. The investigation of particular cases provides a means for experimental determination of the coefficient of viscosity. Cp. article by the same author in *Comptes Rendus*, vol. 152, pp. 1128 and 1743.

Steam Engineering

INVESTIGATION OF A POSITIVE STEAM ENGINE VALVE GEAR WITH RESPECT TO MASS PRESSURES (*Untersuchung einer zwangläufigen Dampfmaschinensteuerung auf Massendrücke*, O. Kölsch. *Dinglers polytechnisches Journal*, vol. 328, nos. 5 to 9, pp. 65, 88, 103, 118, 136, February 1 to March 1, 1913. 13 pp., 11 figs. *e*). Investigation of the slow-speed positive *Frikart valve gear*. It was found by graphodynamic methods that the journals are subjected only to slight pressures. The magnitude of the reaction moments on the steering shaft have been determined, both absolutely and in their functional relation to the time, and from the reaction moments-time curve it is shown by harmonic analysis that resonance can occur only when the natural frequency of the regulator "built in in the machine" is equal to the speed of rotation of the engine or a product of it by an integral.

MESTRE SYSTEM SQUIRREL CAGE SUPERHEATER FOR TUBULAR BOILERS (*Le surchauffeur en cage d'écureuil système Mestre, pour chaudières tubulaires*, P. Lachasse. *Revue Industrielle*, vol 44, no. 9, p. 113, March 1, 1913. 2 pp., 18 figs. *d.*). Description of the Mestre squirrel cage superheater as applied to locomotive boilers.

PERMUTIT IRON ELIMINATION PLANT OF THE WILHELMSBURG WATER WORKS (*Die Permutit-Enteisenungsanlage des Wasserwerkes Wilhelmsburg*, Hencke. *Journal für Gasbeleuchtung*, vol. 56, no. 10, p. 234, March 8, 1913. 1. p., 1 fig. *d*). From a paper read at the 14th annual meeting of the Gas and Water Engineering Society of Lower Saxony in Rendsburg (1912), containing data of the work of the permutit plant during one year. The water flows from the pumps through four permutit filters connected in parallel, potassium permanganate solution having been previously added to it. The filters consist of cylindrical vessels, 2 m (6.56 ft.) in diameter, and about 3.8 m (say 12.5 ft.) high; the water flows at a velocity of 20 m (65 ft.) per hour in a downward direction. Initially the water had a strong smell of hydrogen sulphide and a content of 0.56 mg of Fe_2O_3 per liter. The addition of potassium permanganate produced an evolution of oxygen which converted the hydrogen sulphide into sulphuric acid, and ferrous oxide into ferric. A layer of marble chips takes care of the free

carbon dioxide present in the water, while the permutit acts in the first place mechanically as a filter retaining the finely divided oxide of manganese and ferric oxide, and in the second place chemically, as a regulator of the supply of oxygen, either giving or taking it up in accordance as the potassium permanganate solution is either too strong or too weak.

In the quarter from July 1 to September 30, 1912, 176,707 cbm (6,237,500 cu. ft.) of water have been pumped, with iron content as above. The water finally obtained was free from all smells; 44 kg (say 97 lb.) of permanganate was used, costing M.35.64 (say $8.40). The permutit installation itself cost M.31,000 (say $7,440), while the piping involved an additional outlay of M.4,500 ($1,080). No further cost data are given in the article.

System of Piston Construction for the Prevention of Wearing Out-of-truth of Horizontal Steam Piston Cylinders (*Dispositifs de con-*

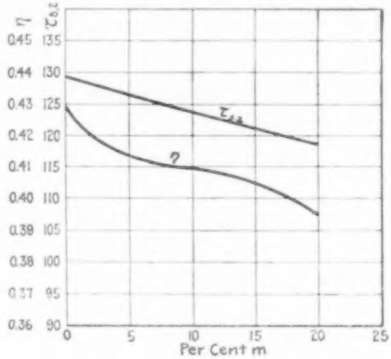

Fig. 9 Air Leak in Economizers

struction des pistons destinés à prévenir l'ovalisation des cylindres à vapeur horizontaux, O.-H. Wildt. *Revue de mécanique*, vol. 32, no. 2, p. 169, February 28, 1913. 7 pp., 8 figs. *dp.*). General description of the methods used for protecting the cylinders of horizontal engines from wearing out-of-true owing to the action of the piston. Leflaive & Co., of St. Etienne, France, have in their steam engines steel piston with a cast-iron belt in the lower part; the weight of the piston rests on this belt which also constitutes its wearing face, the advantage of this construction being in avoiding the rapid wear of the cylinder by friction of steel on cast iron.

On the Influence Exercised by Cold Air Leaks on the Efficiency of Economizers (*Sull'influenza che le chiamate d'aria fredda esercitano sul rendimento degli economizzatori*, G. Ghersina. *L'Industria*, vol. 27, no. 12, p. 179, March 23, 1913, 2 pp., 1 fig. *et*). Investigation on the influence of air leaking, usually in considerable quantities, in economizers through openings in tube scrapers, cracks in walls, and in particular untight connections between the walls and the metallic parts of the economizer. Since in most cases the flow of the two fluids, hot gases and water, is at right angles to one another, the author assumes that in a section normal to the velocity of the flow of the hot

gases, their temperature is equal at every point, while the temperature of the water is assumed to be equal to the arithmetic average between those of entering and leaving water. This being assumed, let L_o be the length of the economizer measured positively in the direction of the velocity of the hot gases, S area of heat transmission per meter of length of economizer, A weight of water per hour passing through the same unit length of economizer with entering temperature t_1 and leaving t_2; G_o is the weight per hour of the hot gases (at temperature τ_o and specific heat at constant pressure c_o) passing from the furnace to the economizer, while G_1 is the weight of the air (temperature τ_1 and specific heat c_1) entering into the economizer through cracks from the section $L=0$ to $L=x$. In this case G_1 is a function of x and the weight of the gas passing through section $L=x$ is

$$G=G_o+G_1(x),$$

the amount of losses in the economizer evidently depending on the form of the $G_1(x)$ function, since, had all the air entered at $x=0$, it would lower the temperature of the entire mass of gases, and consequently decrease the amount of heat transmitted to the water; should it, on the other hand, enter at the other end, at $x=L_o$, it would not affect the efficiency of the economizer at all, though

TABLE 2 AIR LEAK IN ECONOMIZERS

m	0.00	0.05	0.10	0.15	0.20
g_o (kg/hr)	0	53.2	106.4	159.6	212.8
a	229	241.7	254.4	267.0	279.7
b	12520	12836	13153	13469	13786
p	0	12.7	25.4	27.1	50.7
τ_{L_2} (deg. cent.)	129.0	126.4	123.8	121.2	118.6
η per cent	42.9	41.3	40.9	40.4	39.5
t_2 (deg. cent.)	106.0	104.2	103.8	103.3	102.3

it might produce certain disturbances in the stack action. The author, however, considers only the case of air leaking in uniformly along the entire length of the economizer, so that

$$G_1(x)=\frac{x}{L_o}G_1(L_o)$$

or, with $\dfrac{G_1(L_o)}{L_o}=g_o$

$$G=G_o+g_ox$$

where g_o is the weight of air leaking in per hour per meter length of the economizer. He denotes by C the heat in calories lost per hour per meter of economizer length by radiation and convection, C being independent of x, and establishes the following heat balance for a section of the economizer comprised between two planes at a distance dx from one another. This heat balance is composed of the following heat values: (a) heat carried by the gaseous flow: $(G_oc_o+g_oc_1x)\tau$; (b) heat introduced with the water At_1dx; (c) heat coming from the air: $g_oc_1\tau_1dx$; (d) heat carried away by the gaseous flow: $[G_oc_o+g_oc_1(x+dx)]$ $(\tau+d\tau)$; (e) heat taken up from the water At_2dx; (f) heat Cdx lost by the length

dx of the economizer. The heat balance may be therefore expressed as follows:

$$(G_oc_o+g_oc_1x)\,\tau+At_1dx+g_oc_1\tau_1dx=[G_oc_o+g_oc_1(x+dx)]\,(\tau+d\tau)+At_2dx+Cdx$$

or, after certain simplifications, as

$$-(G_oc_o+g_oc_1x)d\tau=[A(t_2-t_1)+g_oc_1(\tau-\tau_1)+C]dx\ldots\ldots\ldots\ldots[1]$$

A second equation is obtained by noting that through the area Sdx of a section of the economizer of length dx passes an amount of heat $A(t_2-t_1)dx$, given an average difference of temperatures of the two fluids $\tau-\frac{t_1+t_2}{2}$. With k as a coefficient of heat transmission that leads to the equation:

$$k\left(\tau-\frac{t_1+t_2}{2}\right)Sdx=A(t_2-t_1)dx\ldots\ldots\ldots\ldots[2]$$

which after certain simplifications and substitutions becomes

$$-\frac{1}{a}\,\frac{d(a\tau-b)}{a\tau-b}=\frac{1}{p}\,\frac{d(px+P)}{px+P}\ldots\ldots\ldots\ldots[3]$$

P and p being the weights, expressed in units of water, of the quantities G_o of hot gases and g_o of air. This equation integrated between the limits τ_o and τ and the corresponding zero values, gives

$$-\frac{1}{a}\log\frac{a\tau-b}{a\tau_o-b}=\frac{1}{p}\log\frac{px+P}{P}\ldots\ldots\ldots\ldots[4]$$

which solves the problem in permitting τ to be determined as a function of x and known quantities, and from this, by means of equation [2], temperature t_2 of leaving water, and finally efficiency of the economizer. If it be further assumed that there are no air leaks, or that $g_o=0$, equation [3] becomes (integrated):

$$\frac{P}{a}\log\frac{a\tau'-b}{a\tau_o-b}=-x\ldots\ldots\ldots\ldots[5]$$

and from this and the preceding equation the difference $\tau'-\tau$, and consequently heat losses due to air leaks may be determined.

The following example is intended to show the use of these equations. A Green economizer has 224 tubes, 210 qm (2260 sq. ft.), with a length $L_o=8.20$ m (26.8 ft.), thus making $S=25.5$ mq. The total weight of water entering the economizer is 4669 kg (10,272 lb.), making $A=569$ kg (1252 lb.), entering the economizer with a temperature of 60 deg. cent. (140 deg. cent.). The weight of the hot gases entering the economizer per hour is $G_o=8730$ kg (19,206 lb.), with a temperature 234 deg. cent. (453.2 deg. fahr.), and specific heat at constant pressure $c_o=0.245$. It is assumed further that the economizer loses by radiation per hour 10,000 calories (39,680 B.t.u.), which makes $C=1220$ calories, or 4825 B.t.u., the coefficient of heat transmission is assumed to be $k=11.0$. The temperature of outside air $\tau_1=25$ deg. cent. (77 deg. fahr.), and its specific heat $c_1=0.238$. Then:

$a=229+0.238\,g_o$; $b=12520+5.95\,g_o$; $P=2140$; $p=0.238\,g_o$.

Equation [5] becomes

$$\frac{2140}{22g}\,l_n\,\frac{22g\tau'-12520}{41066}=-x$$

and for $x=$	0	2	4	6	8	8.2	
τ'	234	200	172	149	131	129	deg. cent.
τ'_{fahr}	453	392	341.6	300.2	267.8	264.2	deg. fahr.

The quantity of heat brought by the gases into the economizer is $Q_o = P\tau_o$, while that taken out is $Q' = P\tau'_{8\text{-}2}$; heat losses by radiation, etc., are CL_o. Consequently, $Q_o - Q' - CL_o$ is the heat passing into the water per hour, and the efficiency of the economizer is expressed by

$$\eta = \frac{Q_o - Q' - CL_o}{Q_o}$$

which, in no air leak operation is equal to $\eta' = 0.429$. Assume now that there are air leaks equal respectively to 5, 10, 15, 20 per cent of G_o, the weight of the hot gases entering the economizer. Then $g_o = m$, with $m = 0.05$, 0.10, 0.15, 0.20. Inserting the corresponding values of g_o into the respective expressions for a, b and p, and calculating only values of τ for $x = L_o$ (they are denoted by $\tau_{8\text{-}2}$) the values in Table 2 are obtained, for which compare also Fig. 9.

Oddie-Simplex Steam-Air Pumps (*Oddie-Simplex Dampf-Luftpumpe*, Prg. *Zeits. des Vereines deutscher Ingenieure*, vol. 57, no. 11, p. 434, March 15, 1913, 2 pp., 8 figs. *d*). Description of a new air pump, built by Maschinenfabrik Oddesse in Oschersleben, Germany. In addition to the usual bottom valve *a*, piston valve *b* and cover valve *c* (Fig. 10 A) it is provided with one or two supplementary suction valves *d* not balanced by springs, and therefore opening at very slight pressures, while the piston valve *b* is set to open only at 0.3 atmospheres pressure. Through the suction opening *e* steam, air, and water are admitted to the space under the piston, but only steam and air to that above the piston, so that the pump works as a combined dry and wet pump, the amount of air and steam admitted above the piston being the greater the later the piston valve *b* opens, or the lower the condenser pressure. In consequence, while in ordinary single-acting three-valve pumps the amount of steam and air handled decreases with improvement in vacuum, this is nearly entirely eliminated here by the second suction stroke on the upper side of the piston; the gain in active space, as compared with the single-acting air pump, may rise as high as 70 per cent, with a corresponding reduction in power consumption and space required for the same amount of work done.

Fig. B to F shows the general arrangement and details of the Simplex valve gear, with its main valve *f* displaced longitudinally by the steam pressure, and rotated about its longitudinal axis from the piston rod by the rod *g*. Over the ends of the slide valve are set caps *i* of which the slots *k* can be brought from outside against the slot *l* in the valve, and which is elastically connected with the valve-gear rod *m*, making the slide valve *f* lie in good contact with the glide face. The live steam enters the chambers *n* of the slide valve through the slots *k* and *l* by way of the throttling valve *o*, with considerably reduced pressure, because on its downward stroke the piston has to do less work than on the upward stroke. The valve is opened wide before the pump is started because the pump is full of water, but is gradually closed as the vacuum in the condenser rises until the pump works with equal speed on the upward and downward strokes of the piston. The slide-valve caps *i* are surrounded by steam all the time, and therefore cannot jam the slide-valve through unequal expansion.

In the position of the valve *f* shown in Fig. B, throttled live steam enters into the left slide-valve chamber *n*, and from there through the left pas-

sage *p* (Fig. F) to the upper side of the steam piston *q* (Fig. A), the exhaust *r* for the lower side being opened simultaneously. In addition through one of the small slots *s* (in this case the lower slot in Fig. F) and the duct corresponding to it, steam flows between the left outside surface of the slide-valve and the cap *i*, thus holding the slide-valve in its final position on the right. When the piston moves, the slide-valve is so rotated that the admission of steam is cut off at about 65 per cent of the stroke, and the piston completes its stroke under the action of the expanding steam. At the last moment of the stroke the valve is displaced back

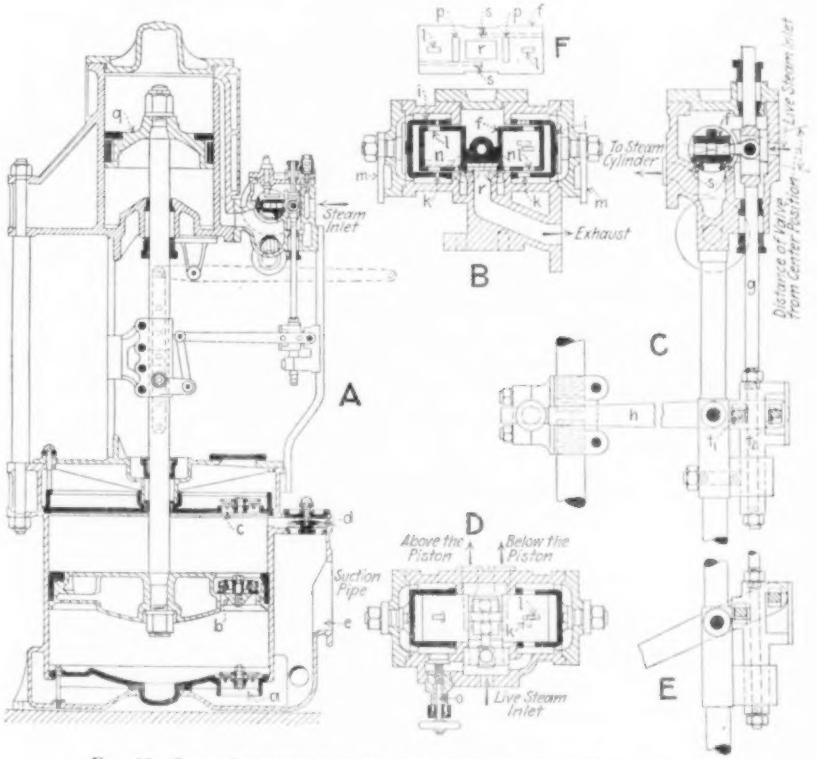

Fig. 10 Oddie-Simplex Steam Air Pump and Simplex Valve-Gear

in the longitudinal direction through the lower slot *s* coming in connection with the exhaust, and the upper with the live steam, which is thereby admitted between the valve and cap on the right side. Now live steam is admitted under the piston, and drives it upwards, the reverse motion occurring without shock because by this time the velocity of the piston is already considerably reduced by the expansion of the steam and the work done by the pump piston. As a rule, throttled steam, and not live, is used for the sake of economy in valve gears, throttled steam being admitted to the space above the slide-valve through *s*, Fig. F.

Strength of Materials and Materials of Construction

Waterproof and Airtight Fabrics (*Les tissus imperméables*, D. de Prat. *Le Génie Civil*, vol. 62, nos. 20 and 21, pp. 384 and 412, March 15 and 22, 1913, 6½ pp., 11 figs. *dg*). A somewhat general description of various processes used for making waterproof and airtight cloth, apparatus used in these processes and, briefly, methods of testing permeability of cloth to water and air. Data are given on the cloths used for the principal types of European dirigible airships.

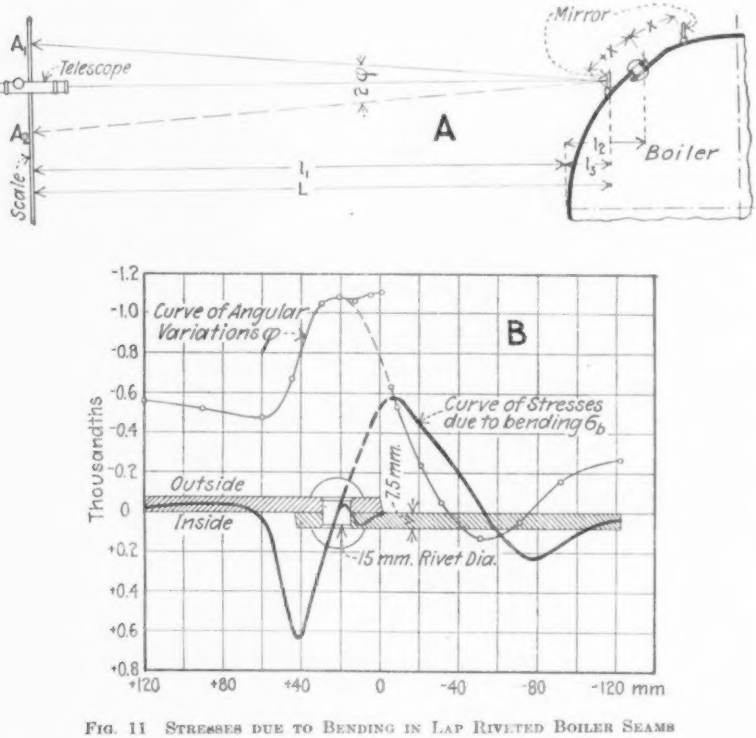

Fig. 11 Stresses due to Bending in Lap Riveted Boiler Seams

On the Influence of Cold-Working and Annealing on the Properties of Iron and Steel (*Über den Einfluss der mecanischen Formgebung auf die Eigenschaften von Eisen und Stahl*, P. Goerens. *Stahl und Eisen*, vol. 33, no. 11, p. 438, March 13, 1913, 7 pp., 12 figs. *et*). Abstract of the first part of the author's article printed under the above title in the Carnegie Scholarship Memoirs of the Iron and Steel Institute, no. 3, 1911.

Corrosion and Rusting Tests of Sherardized Wrought Iron (*Korrosions und Röstungsversuche an sherardisiertem Schmiedeeisen*, Fr. Halla. *Zeits. für Elektrochemie*, vol. 19, no. 5, p. 221, March 1, 1913, 5 pp., 7 figs. *e*). Description and data of tests of properties of *sherardized wrought iron* made at the laboratory of the Royal Bureau for the Promotion of In-

dustry. The relation between the thickness of the layer of zinc and conditions of test in the case of wrought iron was investigated, as well as the speed of corrosion, the latter being expressed in curves. As to phenomena of rusting, it was found that with samples of sherardized wrought iron placed in water, white flocks of zinc hydroxide formed after one day, which very soon began to assume a yellowish color, thus showing the beginning of the process of iron rusting. Deep rusting took place, however, only where the layer of zinc was particularly thin, or when two iron pieces came in contact, so that, on the whole, sharardization seems to protect the iron from rusting.

STRESSES DUE TO BENDING IN LAP RIVETED BOILER SEAMS (*Die Biegungsspannungen in überlappten Kesselnietnähten*, E. Daiber. *Zeits. des Vereines deutscher Ingenieure*, vol. 57, no. 11, p. 401, March 15, 1913, 6 pp., 10 figs. *e*). Data of tests of stresses due to bending in lap-riveted boiler seams, and discussion of a method for the determination of these stresses, as well as of the main factors determining their magnitude. The tests were made on eight boilers. The stresses investigated were determined by finding the angle variation φ of the boiler shell when the boiler was subjected to pressure.

To do this, little mirrors were placed at different points on the circumference of the boiler (Fig. 11 A) and the variation of their position determined in the usual manner by a telescope and scale. The mirrors were attached to a boiler shell by wax, which proved to be the best material to be used for this purpose, and for purposes of measurement the middle of the wax piece, 5 to 6 mm (0.19 to 0.23 in.) wide was considered. Cold pressure produced by an ordinary hand pump was applied, in one case three pressure stages 2 to 6, 6 to 10, and 10 to 14, atmospheres, but as it was found that the angular variation of the mirror was proportional to the pressure, the other tests were carried out with one pressure only, at least as high as the working pressure for the given boiler. No residual angular variations were observed, this probably being due to the fact that the boilers had previously been under pressure.

The first test was made with a small locomotive boiler, 600 mm. (23.6 in.) in diameter, with walls 7.5 mm. (0.3 in.) thick, and a single riveted seam about 1500 mm. (say 60 in.) long. The angular variations were determined between the initial pressure of 5.3 and final pressure of 10.5 atmospheres absolute. The following dimensions were determined (Fig. A): $l_1 = 6140$ mm., $l_2 = 220$ mm.; hence for the point $x = 90$ mm. distant from the lap edge; $l_3 = 130$ mm. and $L = l_1 + l_3 = 6279$ mm. For the same point the following telescope readings have been made:

At initial pressure of 5.3 atmospheres .... $A_1 = 10.30$
With pressure raised to 10.5 atmospheres .... $A_2 = 10.17$
With pressure reduced to 5.3 atmospheres .... $A_3 = 10.30 = A_1$

Showing an elastic variation corresponding to the difference of readings $\triangle A = A_2 - A_1 = -0.13$. The unit of the scale used was 5 cm. long, and the angular variation was therefore:

or numerically

$$\left.\begin{aligned}\varphi &= \frac{5\triangle A}{2L} = \frac{\triangle A}{0.4L} \\ \varphi &= \frac{-0.13}{251} = -\frac{0.52}{1000}\end{aligned}\right\} \qquad [1]$$

The angular variations φ are shown in Fig. 11 B (numerical values are given also in a table in the original) as ordinates, with x (cp. Fig. 11 A) as abscissae, and a smooth curve drawn through the φ points showing the bending moments at each point of the boiler shell. From the differential equation of this line,

$$\frac{d^2y}{dx^2} = \frac{d\varphi}{dx} = \frac{xM_b}{\Theta} \qquad [2]$$

is derived the expression for the bending moment

$$M_b = \frac{\Theta}{a}\frac{d\varphi}{dx} \qquad [3]$$

Where a is the coefficient of elongation of the material, and Θ the moment of inertia of the boiler shell from which a strip 1 cm wide is cut out; hence:

$$\Theta = \frac{s}{12} \qquad [4]$$

where s is the thickness of the wall. The stresses due to bending in the outside fibers, and corresponding to a given moment, are therefore,

$$\sigma_b = \frac{s}{2}\frac{M_b}{\Theta} = \frac{s}{2a}\frac{d\varphi}{dx} \qquad [5]$$

It appears from equations [3] and [5] that both the bending moments M_b and the maximum stresses due to bending σ_b at any point (x,O) are proportional to the angle $\frac{d\varphi}{dx}$ of the tangent at (x,φ) and the curve of angular variations φ. Information as to the magnitude and distribution of stresses due to bending in the neighborhood of a lap-riveted joint may therefore be obtained graphically by drawing at various points tangents to the curve of angular variations φ, determining their inclination with due regard to the scale used, and multiplying the figures obtained by the constant $\frac{s}{2a}$. This method gives only stresses due to bending when the pressure is varied from 5.3 to 10.5 atmospheres but the author gives a method for reducing these data to any pressure whatever. He shows also that the shearing stresses occurring in these cases are of but little importance in the total stress on the material. With regard to Fig. 11 B attention is called to the fact that the curve of stresses due to bending σ_b is drawn on that side of the figure of the boiler sheet in which at bending a tensile stress was produced.

The second part of the article, an analytical method for the calculation of stresses due to bending, can not be abstracted here owing to lack of space.

Miscellanea

The Production of Moving Pictures in Factories (*Die Herstellung kinematographischer Bilder in Fabriken*, G. A. Fritze. *Zeits. des Vereines deutscher Ingenieure*, vol. 57, no. 12, p. 454, March 22, 1913. 7 pp., 10 figs. *d*). Moving pictures of factory processes have, in addition to their educational value, also an advertising value, and act as silent but eloquent salesmen, in giving outsiders an idea of the size and capacity of the plant represented. The pictures should be taken and films made by a concern that makes a business of it, rather than by home means, and the price for a 250 m (820 ft.) film need not exceed M.1000 (say $240). The author discusses fully the best system of lighting for making such photographs,

Fig. 12 Fireproof Storage of Drawings

position of apparatus, and similar phototechnical details. (The method is entirely different from that of Thomas A. Edison who makes his films from technical processes not from the actual shop processes, but from specially prepared models; e.g., the Bessemer converter films are made with a glass model of a converter, and colored ink instead of molten steel.)

Melters' Fever (*La fièvre des fondeurs, Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, vol. 119, no. 2, p. 322, February 1913, *g*). Abstract of an article in *Annales d'hygiène*, January 1913, pp. 82-93, by L. Bargeron. After investigating a large number of cases of diseases of metal melters, the author concludes that fumes of copper in themselves are practically harmless, and that what is known as melters' fever is due to fumes of oxide of zinc exclusively. These fumes produce in the organism a kind of temporary intoxication, and their action may be aggravated by alcoholism or diseases of kidneys or liver. The disease is not considered

to have usually grave consequences, and may be entirely eliminated by simple hygienic precautions, of which the best is good ventilation.

PROGRESS IN WIND MOTORS (*Le progrès des moteurs à vent, L'Electricien*, ser. 2, vol. 45, no. 1160, p. 184, March 22, 1913, 1 p., 6 figs. *d*). A brief description of wind motor types, including that of the Turnbull aeromotor recently shown at an exhibition in Sydney, Australia.

FIREPROOF STORAGE OF DRAWINGS (*Procédé de préservation des plans et dessins industriels contre l'incendie*, B. Beaussart. *Revue industrielle*, vol. 44, no. 12, p. 155, March 22, 1913. *d*). Description of the plan of storing drawings adopted by Bollinckx. In this concern all the drawings are made on tracing cloth from which blueprints are made when required. The tracing cloth drawings have therefore to be stored. All are of uniform dimensions, 0.80 m by 1.20 m (say 31.4 in. by 48 in.). Each drawing is put into a clay tube which in its turn is placed into an appropriate opening in a concrete wall (Fig. 12). Each tube is slanted towards the front, so that should any water penetrate into it, it would not stay there; there is however little chance of that because each tube is provided with a stamped sheet-iron cover on the top. In the illustration is shown a ladder for reaching the upper layers of drawings. This system proved to be remarkably convenient; it has been used for four years, and the drawings keep in perfect condition, due probably to the constant temperature in the concrete structure.

F. W. TAYLOR'S PRINCIPLES OF SCIENTIFIC MANAGEMENT FOR CONCERNS OF ALL KINDS (*F. W. Taylor's Grundsätze methodischer Anleitung bei Arbeitsvorgängen jeder Art*, F. Neuhaus. *Zeits. des Vereines deutscher Ingenieure*, vol. 57, no. 10, p. 367, March 8, 1913, 4 pp. *d*). With the growth of industry in Germany, as everywhere else, the supply of labor could not follow the demand, and the wages rose more and more. This naturally led to means for reducing the cost of production, and the last ten or fifteen years have witnessed an intense activity in equipping the shops with *labor-saving devices, automatic machinery*, etc. But, except in some of the largest plants, the introduction of *labor-saving systems of management* have been retarded in Germany mainly on account of the large expense, time and attention which they require as compared with the introduction of automatic machinery alone.

The rest of the article contains an exposition of the Taylor system of scientific management in accordance with Mr. Taylor's own writings. As regards German conditions, the author states that as far as practical application of the principles of scientific management is concerned, there is little new in it, and some exceptionally efficient men, particularly in the large works, have used it more or less for years, but it was not systematized and done on a definitely accepted plan, so that often, when the particular manager left the works, things were apt to drift back into the usual routine. The Taylor system does not by any means eliminate the importance of the manager's personality, but makes possible a systematic effort towards raising *the efficiency of the plant*. The *German labor papers* appear to have already taken a stand against scientific management. Their main objec-

tions are that it makes of the workman a machine, or, as one paper expressed it, a "beast of burden," to which the author replies that there is really more monotony in the usual occupations than there is likely to be under scientific management, with the additional advantage of the latter that under it there is more chance for the workman to be placed at a congenial kind of work than when the management takes no systematic interest in what each man is doing. The second objection is that it is unjust not to give the laborer the full benefit of his increased production. The author's arguments are that hitherto the plant and tools have not usually been fully utilized, and that the workman is not required under the new system to work either longer or with more effort, but simply by better and more productive methods, found by scientific study of the process; further, that the workman himself did not contribute anything to this increased production, which is due mainly to the labor and expense on the part of the management, and that even if the workman does not get an increase in wages commensurate with the increase in production, the nation is fully benefited thereby.

COMPOUND UNITS

Symbols	Continental Units	American Equivalents	Logarithms of Factors of Equivalence
gr/cm	gram per centimeter	0.0055 lb. per in.	$\bar{3}.74816$
kg/m	kilogram per meter	0.055 lb. per in.	$\bar{2}.74816$
kg/km	kilogram per kilometer	3.54 lb. per mile	0.54900
kg/qcm	kilogram per square centimeter	14.22 lb. per sq. in.	1.15300
kg/ha	kilogram per hectar	0.89 lb. per acre	$\bar{1}.94939$
kg/Morgen	kilogram per Morgen	3.49 lb. per acre	0.54282
t/m^2	metric ton per square meter	0.102 short tons per sq. ft.	$\bar{1}.01033$
kg/m^3	kilogram per cubic meter	0.062 lb. per cu. ft.	$\bar{2}.79518$
kg/hl	kilogram per hectoliter	0.083 lb. per gallon	$\bar{2}.91907$
t/m^3	metric ton per cubic meter	62.4 lb. per cu. ft.	1.79518
kg/h.p.	kilogram per Continental horsepower	2.23 lb. per American h.p.	0.34830
kg/t	kilogram per metric ton	2 lb. per short ton	0.30103
kgm/kg	kilogram-meter per kilogram	3.28 ft.-lb. per lb.	0.51587
kgm/qcm	kilogram-meter per square centimeter	46.58 ft.-lb. per sq. in.	1.66819
t/km	metric ton per kilometer	1.77 short tons per mile	0.24797
t-km	metric ton-kilometer	0.6849 short ton-miles	$\bar{1}.83562$
Costs			
Fr/m	Franc per meter	0.058 cents per ft.	$\bar{2}.76342$
M/m	Mark per meter	0.072 cents per ft.	$\bar{2}.85733$
Fr/t	Franc per metric ton	$0.175 per short ton	$\bar{1}.24303$

COMPOUND UNITS—*Continued*

M/t	Mark per metric ton	\$0.216 per short ton	$\bar{1}.33445$
Fr/qm	Franc per square meter	\$0.018 per sq. ft.	$\bar{2}.25527$
M/qm	Mark per square meter	\$0.022 per sq. ft.	$\bar{2}.34242$
Fr/cbm	Franc per cubic meter	\$0.0054 per cu. ft.	$\bar{3}.73239$
M/cbm	Mark per cubic meter	\$0.0067 per cu. ft.	$\bar{3}.82607$
Fr/ha	Franc per hectar	\$0.078 per acre	$\bar{2}.89209$
M/Morgen	Mark per Morgen	\$0.36 per acre	$\bar{1}.55630$
Fr/h.p.	Franc per Continental horsepower	\$0.195 per American h.p.	$\bar{1}.29003$
M/h.p.	Mark per Continental horsepower	\$0.241 per American h.p.	$\bar{1}.38201$
Fr/Cal	Franc per calorie	\$0.048 per B.t.u.	$\bar{2}.68124$
M/WE	Mark per Wärmeeinheit	\$0.060 per B.t.u.	$\bar{2}.77815$
Fr/t-km	Franc per ton-kilometer	\$0.281 per short ton-mile	$\bar{1}.44870$
M/t-km	Mark per ton-kilometer	\$0.347 per short ton-mile	$\bar{1}.54032$
Fr/kg	Franc per kilogram	\$0.087 per lb.	$\bar{2}.93951$
M/kg	Mark per kilogram	\$0.108 per lb.	$\bar{1}.03342$

HEAT UNITS

Calorie	=WE (Wärmeeinheit)	3.968 B.t.u.	0.59857
C/kg	Calorie per kilogram	1.80 B.t.u. per lb.	0.25527
WE/kg	Wärmeeinheit per kilogram	1.80 B.t.u. per lb.	0.25527
C/qm	Calorie per square meter	0.368 B.t.u. per sq. ft.	$\bar{1}.56584$
WE/qm	Wärmeeinheit per square meter	0.368 B.t.u. per sq. ft.	$\bar{1}.56584$
C/cbm	Calorie per cubic meter	0.112 B.t.u. per cu. ft.	$\bar{1}.04921$
WE/cbm	Wärmeeinheit per cubic meter	0.112 B.t.u. per cu. ft.	$\bar{1}.04921$

REPORTS OF MEETINGS

ST. LOUIS MEETING, MARCH 19

At a meeting of the Associated Engineering Societies of St. Louis, in charge of the local committee of The American Society of Mechanical Engineers, on March 19, Prof. Wm. Kent gave an address on Engineering and Common Sense. Over 100 engineers were in attendance. A dinner in honor of Professor Kent preceded the meeting.

BOSTON MEETING, MARCH 25

A meeting of the Society was held in Boston on Tuesday evening, March 25, Henry Bartlett of the local committee presiding. The principal paper of the evening was by Frank W. Reynolds, Mem. Am. Soc. M. E., on the Modern Cotton Mill. Mr. Reynolds discussed the general conditions controlling the site and layout of a standard cotton mill, including the determination of the spaces to be assigned to different departments, their relative location, the handling of material and product, distribution of power, illumination, etc., and the types of building best adapted to housing the several parts of the plant, together with the principal details of their construction. He presented a number of views illustrating these general principles as well as details of special interest.

This was followed by a brief paper on Lighting of Mills, by Albert L. Pearson, Mem. Am. Soc. M. E., in which he discussed the best form of distribution of artificial illuminants, pointing out the special conditions to which each type and size of light was best adapted.

Fred W. Parks, president of the G. M. Parks Company of Fitchburg, Mass., presented a short paper on Air Conditioning for Textile Mills, in which he quoted the results of extended inquiries, showing the practical value of a proper system of humidifiers, and also giving interesting information in regard to heating and ventilation as applied to mills.

These papers were followed by an extended discussion, participated in by F. W. Dean, W. G. Bartlett, A. L. Williston, E. D. Lyle, R. A. Hale, F. M. Gunby, and others, which brought out much further information.

PROVIDENCE DINNER, APRIL 10

The annual meeting and dinner of the Society and the Providence Association of Mechanical Engineers was held at the Crown Hotel, Providence, on the evening of April 10, preceded by a reception in the parlors of the hotel. About 100 members and guests were in attendance.

Prof. T. M. Phetteplace, Mem. Am. Soc. M. E., president of the Providence Association, gave the address of welcome and introduced the toastmaster, William H. Paine. Calvin W. Rice, Secretary of the Society, spoke on the advantage of coöperation among engineers and what is being done

to promote it and Prof. W. H. Kenerson, Mem. Am. Soc. M. E., spoke on the relations of the two organizations represented. Prof. Charles F. Scott, Mem. Am. Soc. M. E., of Yale University was the principal speaker of the evening, taking as his topic the Future of the Engineer. Letters of regret were received from Governor Pothier, Mayor Gainer, Professor Goss and Professor Everett.

NEW YORK MEETING, APRIL 4

An exhibition of the kinetophone and of the latest improvements in the field of moving pictures and sound production was presented on April 4 in the Engineering Societies Building, New York, before the members of the three founder societies, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, through the courtesy of Mr. Thomas A. Edison, Hon. Mem. Am. Soc. M. E., and of the American Talking Moving Picture Company.

John W. Lieb, Jr., Mem. Am. Soc. M. E., presided over the meeting and the necessary explanations of the apparatus displayed were made by Miller Reese Hutchinson, Mem. Am. Soc. M. E., chief engineer of the Edison Laboratory.

A presentation of the proposed application of the moving picture to educational systems was first made, showing Mr. Edison's plan of revolutionizing the teaching of such subjects as geography, natural science, applied arts, and all those in which the phenomena or objects described can not be shown to the pupils. Where descriptions or illustrations from a text book are now necessary, pictures showing the object itself will be used, thus appealing to the child through the most responsive faculty of youth, that of vision. In illustration of this, there were shown on the screen various kinds of pumps, the action of a magnet and an electromagnet, the mutual arrangements of floating magnets in a supporting but non-magnetic medium, the formation of crystals, and certain natural history phenomena, and it was evident that these pictures contained elements of interest even to those fully familiar with the objects presented, who had probably worked out many of the results in their laboratories and designing rooms.

The kinetophone or talking moving picture machine, Mr. Edison's latest invention to be put upon the market, was then demonstrated. The moving pictures and phonograph were shown to be in perfect synchronism, producing a remarkable illusion. While the principle of the action of the apparatus has not yet been made public, it is easy to see the importance of its application not only for purposes of amusement, but also for investigations of a scientific character, in acoustics, machinery noises, air compressor action, disruptive spark phenomena, etc.

NEW HAVEN MEETING, APRIL 16

A meeting of the Society was held in New Haven in the Mason Laboratory of Mechanical Engineering on April 16, with afternoon and evening sessions. E. S. Cooley, chairman of the New Haven local committee, presided at the afternoon session. Papers were presented on General Types of Heating Systems, by Allen C. Staley of the mechanical engineering department of the Sheffield Scientific School, describing various apparatus

with the aid of a profusion of lantern slides; and on the Heating, Ventilating and Humidifying of the Cheney Brothers Silk Mills, by G. H. Miller, Mem. Am. Soc. M. E., in which the automatic system for maintaining constant temperature and humidity day and night the year around in some of the mills of the company, was described. These papers were discussed by W. G. Snow, Mem. Am. Soc. M. E.; R. W. Pryor, Jr., Jun. Am. Soc. M. E.; T. A. Donnely, of the Positive Differential Company; W. F. Goodenough, of the American Radiator Company; Calvin W. Rice, Secretary of the Society; Prof. L. P. Breckenridge, Mem. Am. Soc. M. E.; Frank B. Gilbreth, Mem. Am. Soc. M. E.; and W. J. Baldwin, Mem. Am. Soc. M. E.

An intermission was given at five o'clock for the inspection of new apparatus in the laboratory for experiments of heating boilers and fans. Dinner was served at six o'clock in the Yale Dining Club.

The evening session opened at 7.30 p.m., Prof. Chas. F. Scott, Mem. Am. Soc. M. E., presiding. Greetings from the Society were extended by the Secretary, Calvin W. Rice, and Professor Scott introduced the subject of the evening, Factory Lighting, speaking of the general principles involved as related to the eye and illumination. Clarence E. Clewell of the electrical engineering department of the Sheffield Scientific School, gave a paper on applications of Lighting to Factories, with many illustrations of good and bad lighting, and a clear presentation of modern methods of securing good lighting and its economic value. T. J. Lytle of the Welsbach Company of Philadelphia described the latest improvements in the construction of gas lamps.

A very effective display of forms of gas units suitable for factories and auditorium was arranged through the courtesy of the New Haven Gas Light Company in the laboratory, and an exhibition of the lights was made at the close of Mr. Lytle's presentation.

More than 100 were in attendance at the meeting.

STUDENT BRANCHES

CASE SCHOOL OF APPLIED SCIENCE

The recently organized branch at the Case School of Applied Science, Cleveland, Ohio, has held several meetings, at one of which A. J. Himes, president of the Cleveland Engineering Society, spoke on The Advantages to the Engineer of Membership in an Engineering Society, and at another, E. P. Roberts, Mem. Am. Soc. M. E., gave an illustrated lecture on Some Phases of Power Plant Engineering. Plans are being made for the first annual meeting.

COLUMBIA UNIVERSITY

On March 27, R. V. Wright, Mem. Am. Soc. M. E., addressed the Columbia University Student Branch on Steel Cars and Their Construction.

CORNELL UNIVERSITY

The Sibley College Student Branch held a joint meeting with the American Institute of Electrical Engineers Student Branch on March 26, at which there was a debate on the question, Resolved, that marine power can be more efficiently utilized by the interposition of electric units be

tween the prime mover and the propellers. A. C. Voorhees (1913) and J. B. Norris (1913), on the negative side, won the debate.

LEHIGH UNIVERSITY

At a meeting of the Mechanical Engineering Society at Lehigh University on April 19, Mr. Larkin of the mechanical engineering department spoke of his experiences in beginning work after his graduation from college, and H. A. Freeman, manager of the Davis Regulator Company, gave a talk on Valves and Valve Regulation.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

At the March 17 meeting of the Mechanical Engineering Society, Prof. I. N. Hollis, Vice-President, Am. Soc. M. E., delivered a lecture on The History of Steam Boiler Construction, in which he outlined the development of the steam boiler from the earliest times. The talk was illustrated with lantern slides.

On March 20, the members of the branch and the Electrical Society attended a smoker at the Technology Union, at which an illustrated lecture was given by Prof. H. W. Smith of the electrical department, on his travels among the tribes of the island of Sawarak.

E. H. Peabody, Mem. Am. Soc. M. E., addressed the meeting of March 28, the subject being Oil Burning. The lecture was illustrated with lantern slides.

On April 8, R. E. Curtis, Mem. Am. Soc. M. E., gave an address on Mechanical Drawings and the Drawing Room, in which he discussed the best methods employed in drafting, and the proper way a large drafting room should be conducted.

I. E. Moultrop, Vice-President, Am. Soc. M. E., gave a lecture on Power Plant Difficulties, at the meeting of April 14, in which he discussed boiler capacity, boiler setting, economizers, condensers, stokers and steam piping. A discussion by the student members followed.

PENNSYLVANIA STATE COLLEGE

On April 4, D. R. Mason, metallurgical engineer with the National Tube Co., addressed the Pennsylvania State College Student Branch on the Manufacture of Steel Tubing.

H. A. Hey, Assistant to the Secretary, Am. Soc. M. E., in an address at the meeting of April 8, set forth the advantages of student membership in the Society.

At the meeting of April 11, C. D. Young, Mem. Am. Soc. M. E., lectured upon the present practice in railroad work in the use of superheated steam, electrical engineering in steam road work, and apprenticeship courses for engineering graduates.

POLYTECHNIC INSTITUTE OF BROOKLYN

A meeting of the Polytechnic Institute Student Branch was held on April 5 when Prof. R. H. Fernald, Mem. Am. Soc. M. E., delivered a lecture on Producer Gas from Low-Grade Fuels.

PURDUE UNIVERSITY

At a regular meeting of the Purdue University Student Branch on April 8, Prof. G. W. Munro, Mem. Am. Soc. M. E., presented a Historical Resumé of Gas Turbines, in which he discussed the types and probable development. The talk was illustrated with lantern slides.

STATE UNIVERSITY OF KENTUCKY

At the last regular meeting of the University of Kentucky Student Branch, S. Rosenzweig of the Erie City Iron Works, delivered a lecture on Superheated Steam and Poppet Valve Engines. Lantern slides, showing the detailed construction of engine and valve gears, added interest to the lecture.

STATE UNIVERSITY OF IOWA

At the meeting of the Council on April 11, the establishment of a new student branch at the State University of Iowa was authorized.

STEVENS INSTITUTE OF TECHNOLOGY

On March 7 Jerome Strauss (1913) gave a talk before the Stevens Engineering Society on the Corrosion and Preservation of Iron and Steel. The speaker recalled how the hand-worked iron of former times withstood the attack of corrosive agencies better than the cheaper, quicker-made iron of today, and the theories of corrosion and the methods of protecting iron were discussed.

Dr. Chas. E. Lucke, Mem. Am. Soc. M. E., presented a paper on Heavy Oil Engines at the meeting of March 18. This was discussed by H. Torrance and R. H. Williams.

At the March 27 meeting, Dr. F. J. Pond, profesor of chemistry at Stevens Institute of Technology, delivered a lecture on Synthesis of Rubber. He began his lecture by a brief description of india-rubber or caoutchouc, which is obtained from the sap of certain tropical trees. The sap is coagulated by heat or by means of acid and the main constituent is the caoutchouc hydrocarbons. The principle upon which the synthesis of rubber depends is to produce these caoutchouc hydrocarbons without the aid of the vegetable sap.

The Electrification of the Steam Railroads in the Neighborhood of Boston from a General Economic and Engineering Point of View, by Dr. George F. Swain, Mem. Am. Soc. M. E., was given at the meeting of April 1. He emphasized the point that it was not a question of how to build but whether to build at all, and his considerations, therefore, were not electrical but financial and economic. This was discussed by J. H. Vander Veer (1911).

On April 8, F. E. Ford (1914), presented an illustrated lecture on Hydroelectric Power Development. The main essentials in considering hydroelectric propositions are accessibility of location, market for the product, cost of maintenance and fixed charges. J. H. Vander Veer, R. H. Williams, C. S. Trewin and M. R. Van Benschoten participated in the discussion.

UNIVERSITY OF ILLINOIS

L. D. Breedlove gave a talk on The Prevention of Accidents in Industrial Plants at the meeting of March 7 of the University of Illinois Student Branch, which was followed by a general discussion.

UNIVERSITY OF KANSAS

The fourth annual open meeting of the University of Kansas Student Branch was held March 27. The first session was opened by an address by Prof. P. F. Walker, Mem. Am. Soc. M. E., and the following papers were presented: Failures of Machine Parts, W. H. Tangeman (1912); Temperature Regulation and the Heating Engineer, F. A. DeBoos of the Johnson Service Company, Kansas City, Mo., and Fuel Testing and the Purchase of Coal by Specifications, Dr. Roy Cross. The paper by Mr. DeBoos was illustrated with lantern slides and models.

At the second session, Prof. F. H. Sibley, Mem. Am. Soc. M. E., read a paper on Block Signals. E. E. Howard, of Waddell & Harrington, Kansas City, Mo., gave a talk on The Design and Operation of Lift Bridges which was illustrated with slides of bridges in operation. An illustrated lecture on Superheated Steam and the Lentz Engine was also presented by S. Rosenzweig of the Erie City Iron Works.

In the evening, a banquet was given to the visiting speakers.

UNIVERSITY OF MISSOURI

At a special open meeting of the University of Missouri Student Branch on March 18, Prof. Wm. Kent, Mem. Am. Soc. M. E., delivered a lecture on Engineering and Common Sense.

UNIVERSITY OF WISCONSIN

An interesting exhibit of internal combustion engines was held at the University of Wisconsin, Madison, Wis., on February 27 and 28, by the Student Branch of the Society in coöperation with some of the agricultural students and with the assistance of various manufacturers, W. C. Rowse of the faculty acting as director of the affair. The exhibit was given in the Stock Pavilion of the Agricultural Department, and consisted of tractors, automobiles, motor cycles, general farm engines and utility engines and motor boats. It was open between 10 a.m. and 10 p.m., the machinery being run at certain hours during the day and evening so that the operating factors could be seen. The applications of this type of engine that could not be shown by exhibits were illustrated by lantern slides and lectures. Music was provided by the university regiment on both evenings, and the show proved to be of such a popular nature that the pavilion was crowded to its fullest extent both during the afternoon and evening. Although over a thousand free passes were given out by the dealers participating in the exhibit, and despite the low cost of admission, ten cents, the attendance was so large that over one hundred dollars was realized after the meeting of all expenses.

YALE UNIVERSITY

An engineering exhibit, showing the apparatus in use at the Mason Laboratory of Mechanical Engineering, together with that of certain manufacturing firms, was held at Sheffield Scientific School, Yale University, on February 21 and 22, under the auspices of the student branches of the national societies. It was planned by the students for the benefit of the university and their friends, so that all might examine the equipment of the laboratory. The apparatus included testing machines, special testing apparatus, sewage disposal plant, sanitary chemical analysis of water, testing of reinforced concrete, steam engines, ore testing machinery, electrical machinery, and many others.

NECROLOGY

EDWARD L. BRONSON

Edward L. Bronson, who died at his home in Waterbury, Conn., on February 18, 1913, was born at Wolcott, Conn., on May 18, 1860. His education was received in the public schools and in the Lewis Academy, Southington, Conn. Upon leaving school he apprenticed himself to the Hendey Machine Company in Torrington.

In 1886 he entered the employ of the Waterbury Farrel Foundry & Machine Company at Waterbury, as machinist, and later in the same year resigned to take up similar work with the E. J. Manville Machine Company. Three years later he became connected with J. E. Draper & Company, North Attleboro, as a tool maker, but soon returned to Waterbury to become foreman of the machine department of Blake & Johnson, machinists and manufacturers of piano hardware, etc. In 1896 he again entered the employ of the Manville Company, now as foreman of special machinery and tool making, and remained with them until he became master mechanic of the Shoe Hardware Company, with which he was connected until shortly before his death. His was no small part in the development of the factory to its present importance.

Mr. Bronson was especially interested in automatic machinery and with A. C. Campbell invented an improvement in dress hook machines, which resulted in increasing the speed of production from 70 to 220 hooks per minute.

GEORGE W. CLANCY

George W. Clancy, president of the Globe Chemical Company of Boston, died at his home in Albany on March 10, 1913. Mr. Clancy was born in Albany on February 22, 1881, and after completing his education in the public schools entered the shops of Skinner & Arnold of that city, where he learned the machinist's trade. He then entered the employ of the New York Central at West Albany and was transferred to the Boston & Albany

Railroad in 1904, becoming inspector of shops. In 1908 he left to accept a similar position with the New York, New Haven & Hartford Railroad. While with this company he received an offer to become manager of the railway sales department of the Adams & Elting Company, Chicago, and was with this concern at the time of his death.

COLIN C. SIMPSON

Colin C. Simpson, assistant secretary and general superintendent of mains of the Consolidated Gas Company, died in New York, April 8, 1913. Mr. Simpson was born at Maidstone, England, on December 16, 1856, and received his education in private schools, the Technical High School of Gratz, Austria, and the Naval Academy at Trieste, Austria. He began his career with an English contracting firm laying water mains in Vienna, and during his connection with them invented a machine for tapping mains while under pressure without allowing water to escape.

In 1880 he came to the United States and entered the engineering department of the Knickerbocker Gas Company. Two years later he was placed in charge of mains of the Municipal and Knickerbocker Gas Companies, and at the time of their consolidation in 1884 into the Consolidated Gas Company, was made district superintendent of mains. From this he rose to the general superintendency and also to the position of assistant secretary, in both of which he continued up to the time of his death.

Mr. Simpson had an unusual acquaintance with sub-surface conditions in New York City, having had charge of the design and construction of all gas mains laid in Manhattan since 1884. He designed and successfully laid during 1910 and 1911 two 36-inch and one 48-inch main across the Harlem River, one of the most difficult problems in connection with main work. He also laid the East River Gas Company's 60-inch steel main from the Astoria Works to Ravenswood, the largest gas main in the world. He was the first man to use lead wool for pipe jointing in this country, having imported this material from Germany before it was manufactured here. He was a leading exponent of absolute safety with respect to gas mains, and designed and secured the adoption of the system of bypassing of all gas mains, now in general use during the construction of the subways.

Mr. Simpson had a very wide acquaintance among his profes-

sion and was frequently called upon as an expert in damage suits against gas companies. He appeared before the United States Supreme Court in the New York Eighty-Cent Gas Case and established the value claimed for the mains under his charge. He was a member of the American Gas Institute, the Engineers Club, the Society of Gas Engineering, the Society of Illuminating Engineers, and the National Democratic Club.

CHARLES E. TOMLINSON

Charles E. Tomlinson was born February 14, 1868, in Auburn, N. Y., and was educated in the public schools of that city and of Syracuse. He entered the field of mechanical engineering by serving as an apprentice with a number of firms, including the L. C. Smith Gun Company, LaFevere Arms Company, Weston & Smith and I. Weston & Company, drafting machinists, designers and builders, Duell, Laass & Duell, Emil Laass & Company, Hey, Wilkinson & Parsons and Hey & Parsons, patent solicitors and attorneys, all of Syracuse, N. Y. In 1900 he entered the employ of the Remington Typewriter Company as designer and draftsman, and in 1903 transferred to their Smith Premier plant, with which he was connected at the time of his death, on March 10, 1913. Mr. Tomlinson designed and constructed the various parts of the typewriter for the Remington Company, and during the latter years of his life was occupied mainly in expert work on patents and related questions.

AARON VANDERBILT

Aaron Vanderbilt of Remsenburg, New York, died on March 25, 1913. He was born January 29, 1844, and was educated in the public schools of Staten Island and Brooklyn. Throughout his professional career he was connected with marine work and had no technical training other than that gained by experience.

He was at one time manager of the Ward Steamship Company, and at the time of the formation of the Society, of which he was one of the charter members, superintendent of the New York and Cuba Mail Steamship Company, and from 1900-1908, when ill-health forced him to retire from active work, vice-president of the Wheeler Condenser & Engineering Company. He was especially interested in marine engines and gave much time and study to their development.

During the Civil War while on Admiral Porter's staff he drew plans of the enemy's fortifications at Fort Fisher and elsewhere.

Mr. Vanderbilt was elected to life membership in the Society in 1908. He was a member of the United States Naval Institute, the Naval Order of the United States, the Society of Marine Architects and Naval Engineers, the Navy League, the Grand Army of the Republic, and the military order of the Loyal Legion. He was largely instrumental in the formation of the Naval Reserve and the Navy League, and was at one time chairman of the committee on ocean transportation of the New York Board of Trade.

EMPLOYMENT BULLETIN

The Society considers it a special obligation and pleasant duty to be the medium of securing better positions for its members. The Secretary gives this his personal attention and is pleased to receive requests both for positions and for men. Notices are not repeated except upon special request. Names and records, however, are kept on the current office list three months, and if desired must be renewed at the end of such period. Copy for the Bulletin must be in hand before the 12th of the month. The list of "men available" is made up from members of the Society. Further information will be sent upon application.

POSITIONS AVAILABLE

358 Young graduate mechanical engineer in estimating department of Pennsylvania concern making gas engines and producers, steam engines, boilers, tanks, etc. The work would cover estimating material and labor costs on boiler shop construction; preference for someone who has had actual experience in the boiler shop estimating line, and who can be depended on to stay after becoming proficient in the work. Salary depends on man's capabilities and experience.

359 Foreman in small plate and structural shop. Must be good layer-out and all-around man able to keep accurate cost records and get results. State age, experience, references and salary expected. Location Springfield, Mass.

363 Technical graduate from 25 to 30 years old, as assistant to head of engineering and maintenance departments of firm manufacturing paper and finished paper products. Headquarters in Massachusetts. Should have had general experience in upkeep of an industrial plant rather than some specialty. Applications must include full details as to previous history and salary wanted.

400 Recent graduates in mechanical engineering, who will be ambitious and willing to work hard. Location Niagara Falls, N. Y.

401 Technical expert in purchasing department of a large works near New York, making high-grade light metal products, to assist in selecting, buying and inspecting the many varied materials used. Should be good metallurgist, fair chemist and familiar with fuels. Apply through the Society, giving age, education, experience, reference and approximate salary required.

402 Mechanical engineer with experience in production engineering, or in the Taylor system of scientific management or one having a liking for this kind of work; Cleveland concern.

403 Man with ability to decrease costs and increase production, required to operate rapidly growing department of St. Louis manufacturing plant. Ability to grasp and develop special features is necessary. Practical shop and premium system experience desired. Salary $125 upward.

404 Sales engineer for high-grade steam engines. Must be a man capable to instruct and advise other salesmen. Location New York State.

405 Position open for engineer familiar with steam pumps, centrifugal pumps and air compressors, and with some experience along the line of salesmanship. Michigan concern.

406 Engineer on power plant design, operation, estimating, testing and mechanical construction. Location Massachusetts. Apply through Society.

407 Young technical graduate, familiar with power plant work, experience in stoker construction preferred. Salary $1500; good opportunity for advancement. Location Massachusetts.

409 General superintendent, with wide shop experience and thoroughly conversant with all modern tools and methods, good organizer with ability to handle men to the best advantage. Location Detroit. Apply through the Society.

410 Man to take charge of mechanical end of plant to oversee boiler and steam plants as well as repair work and new construction. Will pay liberal salary for right man with ability to handle men and do the work. Location Chicago.

411 Man with thorough knowledge of metallurgy to undertake the introduction of an important new process of case-hardening. Will need broad engineering training as well as business experience.

412 Instructor in experimental engineering for the school year 1913-1914. Location Oregon.

414 Detailers for steel work of office and mill buildings. Salary $125 a month. Location San Francisco.

MEN AVAILABLE

82 Member, mechanical engineer, desires to hear from manufacturers of power plant equipment and specialties who desire a representative in Rochester, N. Y., and vicinity.

83 Member, 15 years' practical experience, mainly in hydraulics and steam turbine design, now teaching machine design and related subjects for the second year, desires teaching position in machine design or mechanical engineering.

84 Member, technical graduate, 18 years' experience in shop, designing and layouts, testing materials and machines, now teaching, wishes to locate South or East, preferably with consulting engineer or technical school.

85 American, technical graduate, 10 years' experience in design of cranes and hoisting machinery, seeks responsible position with progressive firm as designing engineer, chief draftsman or similar work.

86 Superintendent, Member, age 40, experienced in shop systems, and modern methods of manufacturing Diesel and semi-Diesel oil engines; good executive, with last employer 15 years, desires position as superintendent or works manager. At present employed.

87 Member, at present employed, 18 years' varied experience in design and construction of machinery and buildings, remodeling, maintenance and operation of large industrial plants and equipment, systematizing of shops and processes along the lines of scientific management, testing and general plant engineering; accustomed to handling men, drawing up contracts, purchasing equipment and material, appraising properties: desires to become

identified with manufacturing or industrial plant of prominence in administrative or executive position of responsibility in which his experience may be of value.

88 Graduate mechanical engineer, 8 years' experience, partly drafting and designing, but mainly in research and experimental work along lines connected with steam engineering. At present employed, available about August 15. Best of references.

89 Technical graduate, age 37, practical mechanic with 15 years' experience in executive and designing capacity in varied lines, desires position as superintendent or mechanical engineer. Open to engagement May 1.

90 Technical graduate, age 37, practical mechanic with 10 years' experience in executive capacity, mill engineering, power generation, transmission, etc., desires position as factory engineer or works manager with progressive concern in New England.

91 Member, now employed, with 17 years' experience in design and construction of machinery and buildings, manufacturing, systematizing and accounting, graduate Massachusetts Institute of Technology in mechanical engineering, post-graduate course in electrical engineering, desires permanent administrative or executive position in New York City.

92 Member, 32, desires position in New York or vicinity, with a firm engaged in design and construction of plants, or with industrial engineers. General experience in mill building and in power plants.

93 Manager and engineer equally capable in charge of sales department, advertising, correspondence or shop. Technical degrees of mechanical and electrical engineer (University of Pennsylvania), followed by 9 years of practical shop, drawing-room, office and traveling sales experience. Four years with present firm and manager of a sales department.

94 Associate, age 35, with 17 years' broad experience in drawing-rooms on civil, structural and mechanical work, desires a position of some responsibility (preferably not drawing), in or near Philadelphia. Experience on furnaces, mill work, power plants, chemical apparatus, gas plants, coke ovens, etc. Salary about $1500 to begin.

95 Member, age 33, Cornell, M.M.E., 10 years' practical and technical experience along internal-combustion engine lines, in designing, testing, erecting service and sales work. Specialty, factory production and inspection systems to produce interchangeable parts. At present employed. Desires position of responsibility with stationary gas engine or traction engine concern in the Middle West. Salary $3600. Good references.

96 Technical graduate, 26 years' experience in shop, teaching applied mathematics, experimental mechanics and engineering physics, 15 years in engineering and contracting, covering refrigeration, water supply, power and lighting plants, including machinery and buildings, testing process development and consulting work over a wide range of subjects. At present acting professor of engineering practice in a prominent engineering school. Has no family ties and would like position in Orient or south of equator.

97 Technical graduate, Junior Member, 10 years' practical experience. At present engaged as superintendent of manufacturing concern, but desires to make change to larger field. Experience covers design and manufacture of interchangeable parts and machinery, tools, jigs, and fixtures for increasing production, etc. Good references.

98 Mechanical engineer with long practical shop and drawing-room experience, resourceful in design, especially well experienced as chief draftsman in carrying out designs at reasonable cost in the drawing-room of engines, pumps, heaters and condensers of all descriptions, the specialty, is open for engagement. Splendid record and references.

99 Mechanical engineer having thorough practical knowledge combined with technical education, conversant with steam and water, desires position as master mechanic of large industrial plant.

100 English-speaking graduate German technical school, with foreign experience in landscape architecture and city planning, including surveying, analysis of soils, building construction, canal and railroad construction, hydraulics, meteorology, etc., desires to locate in America.

101 Teacher of mechanical engineering subjects, at present in one of the largest schools in the East, desires to change to Middle or Far West. Eight years' experience, before taking up school work, as designer and chief engineer on steam and gas engineering work, pump compressors and general power plant work. Member. Excellent references. Minimum salary $1800.

102 Designer of broad experience, familiar with presses and dies for sheet metal work, and with tools, jigs and fixtures for efficient production, will soon be available for work of this class in the Middle West.

103 Member, professor of experimental engineering in a large Eastern university, desires summer work. Has had shop experience, engine room service at sea and a general experience in testing work and miscellaneous engineering problems.

104 Member, experienced in engineering and physical research, formerly in charge of design and construction of internal-combustion engines, later in charge of testing laboratory, and thoroughly conversant with latest theory of thermodynamics as teacher, desires an opening in responsible charge or as professor.

105 Power plant specialist and consulting engineer desires connection with editorial staff of leading technical periodical, and working agreement with bankers, investors or others contemplating development along mechanical or industrial lines.

106 Junior member experienced in cost and efficiency work and factory management, at present with financial house; desires position as factory manager of medium-sized industrial plant or assistant to manager of larger works.

107 Student member, will graduate from Stevens Institute in 1913, desires a position in which the prospects are good. Interested in electrical or hydraulic lines.

108 Cornell graduate, age 27, would like to engage in work along engineering sales. Experience in power specialties, boiler and furnace practice, mechanical and works engineer.

109 Experienced executive now located in Cincinnati desires consideration as superintendent or production manager. Experienced on machine tools, autos, and electric machinery, up-to-date on shop management, methods and system, installed the premium system and good success in organizing and handling men, practical experience, technically trained, age 37, married.

ACCESSIONS TO THE LIBRARY

WITH COMMENTS BY THE LIBRARIAN

This list includes only accessions to the library of this Society. Lists of accessions to the libraries of the A. I. E. E. and A. I. M. E. can be secured on request from Calvin W. Rice, Secretary, Am. Soc. M. E.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION. Proc. 19th annual convention. *Chicago, 1909.* Gift of association.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Year Book 1913. *New York, 1913.*

ATTITUDE OF LABOR TOWARDS SCIENTIFIC MANAGEMENT, Hollis Godfrey. Gift of author.

AUTOMOBILTECHNISCHES HANDBUCH, Ernst Valentin. ed. 7. *Berlin, 1913.*

BRITISH FIRE PREVENTION COMMITTEE. Fire Tests with Doors. Red Book no. 173. *London, 1912.*

——Fire Tests with Roof Coverings of Asbestos Cement Corrugated Sheets. Red Book no. 174. *London, 1913.*

CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING. 5th and 7th Annual Reports of the President and of the Treasurer. *New York, 1910, 1912.* Gift of the Society.

LA CHAUFFERIE MODERNE. Alimentation des Chaudieres et Tuyauteries de Vapeur, J. Guillaume and André Turin. *Paris, 1912.*

CIVIL ENGINEER AND ARCHITECT'S JOURNAL. vols. 1–26. *London, 1837–1863.*

CONSTRUCTIONS MÉTALLIQUES, J. Bonhomme and E. Silvestre. *Paris, 1913.*

DIE DAMPFMASCHINEN, A. Pohlhausen. vol. 2. *Mittweida, 1912.*

THE DESIGN OF ALTERNATING-CURRENT MACHINERY, J. R. Barr and R. D. Archibald. *New York, Macmillan Co., 1913.*

The book was written by Mr. Barr, a lecturer in Heriot-Watt College, Edinburgh, and revised by Mr. Archibald. It is for students in advanced electrical engineering, and gives adequate mathematical treatment.

DIESEL-MOTOREN, G. Supino and H. Zeman. *Munchen, Berlin, 1913.*

EDINBURGH UNIVERSITY. Calendar 1912–1913. *Edinburgh, 1912.* Gift of university.

L'EFFET GYROSTATIQUE ET SES APPLICATIONS, E. W. Bogaert. *Bruxelles-Paris, 1912.*

ELECTRIC POWER FROM THE MISSISSIPPI RIVER. bull. no. 9, March 1913. *Keokuk, 1913.* Gift of Mississippi River Power Co.

ETUDE THÉORIQUE ET PRATIQUE SUR LE TRANSPORT ET LA MANUTENTION MECANIQUES DES MATÉRIAUX ET MARCHANDISES DANS LES USINES, LES MAGASINS, LES CHANTIERS, LES MINES, etc., Georg von Hanffstengel. vols. 1–2. *Paris, 1910–1911.*

EXPERIMENTAL STUDY OF HEAT TRANSMISSION AND ENTRAINMENT IN A VACUUM

Evaporator. Louisiana Agricultural Experiment Station, bull. no. 138. *Baton Rouge, 1913.* Gift of Louisiana State University.

Gas Power, C. F. Hirshfeld and T. C. Ulbricht. *New York, J. Wiley & Sons, 1913.*

This elementary manual is designed for students in manual training schools and others who wish to learn enough of the gas engine to serve as an introduction to more advanced works. There is a minimum of mathematical treatment. The authors are members of the faculty of Cornell University.

Die Gebläse, Albrecht von Ihering. ed. 3. *Berlin, 1913.*

Goethals, George W., Banquet Tendered to, by New York Lehigh University Club, January 27, 1913. N. Y. Lehigh University Club.

Great Britain Patent Office Library. Guide to the Search Department. *London, 1913.* Gift.

Harvard University. Reports of the President and the Treasurer, 1911–1912. *Cambridge, 1913.* Gift of university.

Hussey, Obed. Edited by Follett L. Greeno. *Rochester, N. Y., 1912.* Gift of editor.

The book is controversial rather than biographical, and is designed to support Hussey's claims as the original inventor of the reaper.

Hydraulisches Rechnung, R. Weyrauch. ed. 2. *Stuttgart, 1912.*

Über Kapok, E. L. Lincke. *Dresden, 1912.*

Der VI Kongress des Internationalen Verbandes für Material-prüfungen der Technik, New York, 1912, Alfred Deinlein. *Wien, 1913.* Gift of H. F. J. Porter.

Koninklijk Instituut van Ingenieurs. Year Book 1913. *'s-Gravenhage, 1913.* Gift of institute.

Legal Aid Society. 37th Annual Report of the President, 1912. *New York, 1913.* Gift of society.

Lehrbuch der Thermodynamik, J. D. v. d. Waals. *Leipzig, 1908.*

Les Lois Expérimentales des Hélices Aériennes, Alexandre Sée.

Lowell Textile School. Annual Report of the Trustees, 1912. *Boston, 1913.* Gift of school.

Machinists' and Draftsmen's Handbook, Peder Lobben. ed. 2. *New York, Van Nostrand Co., 1910.* Gift of author.

A compilation of facts and tables for the working mechanic. It is full of practical information; an encyclopedia of machine-shop practice.

Neuere Kühlmaschinen ihre Konstruktion Wirkungsweise und industrielle Verwendung, Hans Lorenz and C. Heinel. ed. 5. Oldenburgs Technische Handbibliothek, vol. 1. *München, 1913.*

New York Central and Hudson River Railroad Company. 44th Annual Report to the Stockholders, 1912. *New York, 1912.* Gift of company.

Ohio University. Bulletin of Summer School. *Athens, 1913.* Gift of university.

Pittsburgh Bureau of Water. Annual Report February 1, 1911 to January 31, 1912. Gift of superintendent Bureau of Water.

Poor's Manual of Railroads, 1913. *New York, 1913.*

Précis d'Hydraulique, Georges Daries. *Paris, 1912.*

Public Health Service not a Medical Monopoly, Morris Knowles. Reprinted from American Journal of Public Health. Gift of author.

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STEAM BOILER EXPLOSIONS, W. H. Boehm. *1912.* Gift of Fidelity and Casualty Company of New York.

SYMPOSIUM ON SCIENTIFIC MANAGEMENT AND EFFICIENCY IN COLLEGE ADMINISTRATION. *Ithaca, 1913.* Gift of Society for the Promotion of Engineering Education.

A THOUSAND USES FOR GAS. An alphabetically arranged list of over one thousand uses for gas as applied in the arts and trades. *1913.* Gift of National Commercial Gas Association.

THROOP POLYTECHNIC INSTITUTE. President's Fourth Annual Report. Bulletin April 1913. *Pasadena, 1913.* Gift of institute.

TRANSPORTER BRIDGES, H. G. Tyrrell. *Toronto, 1912.* Gift of author.

UNIVERSITY OF EDINBURGH. Copy Register of Members of the General Council, 1911. *Edinburgh, 1911.* Gift of the Society.

UNIVERSITY OF TORONTO. Calendar, Faculty of Applied Science and Engineering 1913–1914. *Toronto, 1913.* Gift of university.

ÜBER WASSERKRAFT UND WASSER VERSORGUNGSLAGEN, F. Schlotthauer. ed. 2. Oldenbourgs Technische Handbibliothek, vol. 7. *München-Berlin, 1913.*

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ENGINEERING. vol. 36, 1883. *London, 1883.* Gift of John Wiley.

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MOODY'S MANUAL OF RAILROADS AND CORPORATION SECURITIES, 1913. *New York, 1913.*

OIL, PAINT AND DRUG REPORTER. Buyers Directory, 1913. *New York, 1913.* Gift of Oil, Paint and Drug Reporter.

"SWEET'S" CATALOGUE OF BUILDING CONSTRUCTION, 1913. *New York, 1913.* Gift of Wm. B. Bamford.

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———Bericht über die unter dem Vorsitze, Sr. Königl. Hoheit des Prinzen Ludwig von Bayern, June 28, 1903. *München, 1903.*

———Description of.

———Führer durch die Sammlungen. *Leipzig.*

———Mitglieder-Verzeichnis, 1909–1910.

———Verwaltungs Bericht über das Geschäftsjahr 5, 7, 8, 1908–1911. *München, 1908–1911.*

———A Walk Through the Collections.

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PENBERTHY PRESS, *Detroit, Mich.* Penberthy Engineer and Fireman, March 1913.

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WOOD, W. H. LOCO FIRE BOX AND TUBE PLATE CO., *Media, Pa.* Explanatory reference to the diagram of Wm. H. Wood's patent locomotive firebox and tube plates.

OFFICERS AND COUNCIL

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